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Heating · Piping and Air Conditioning

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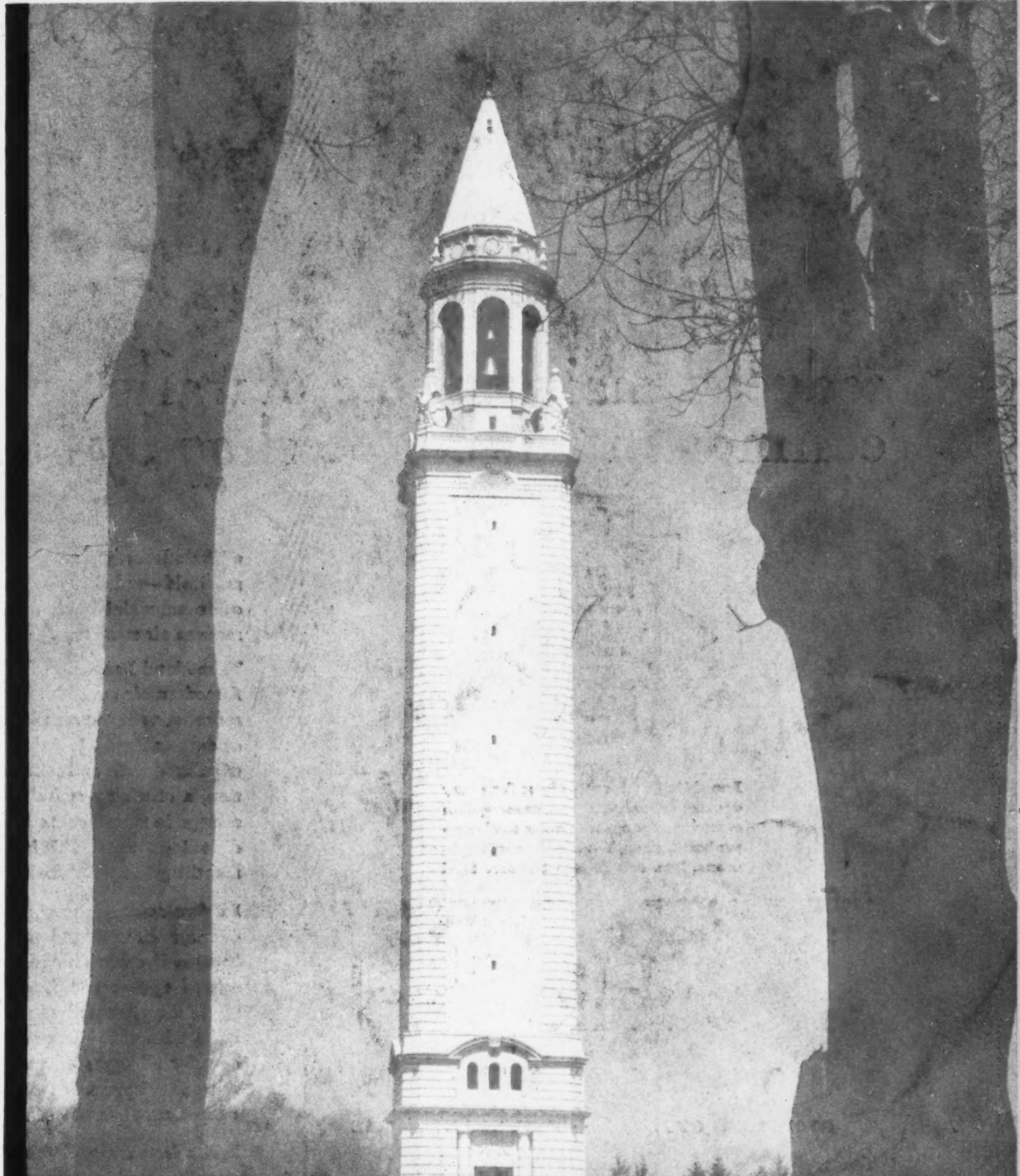

The Nemours Carillon Tower

TOBER, 1936

—Journal Section of
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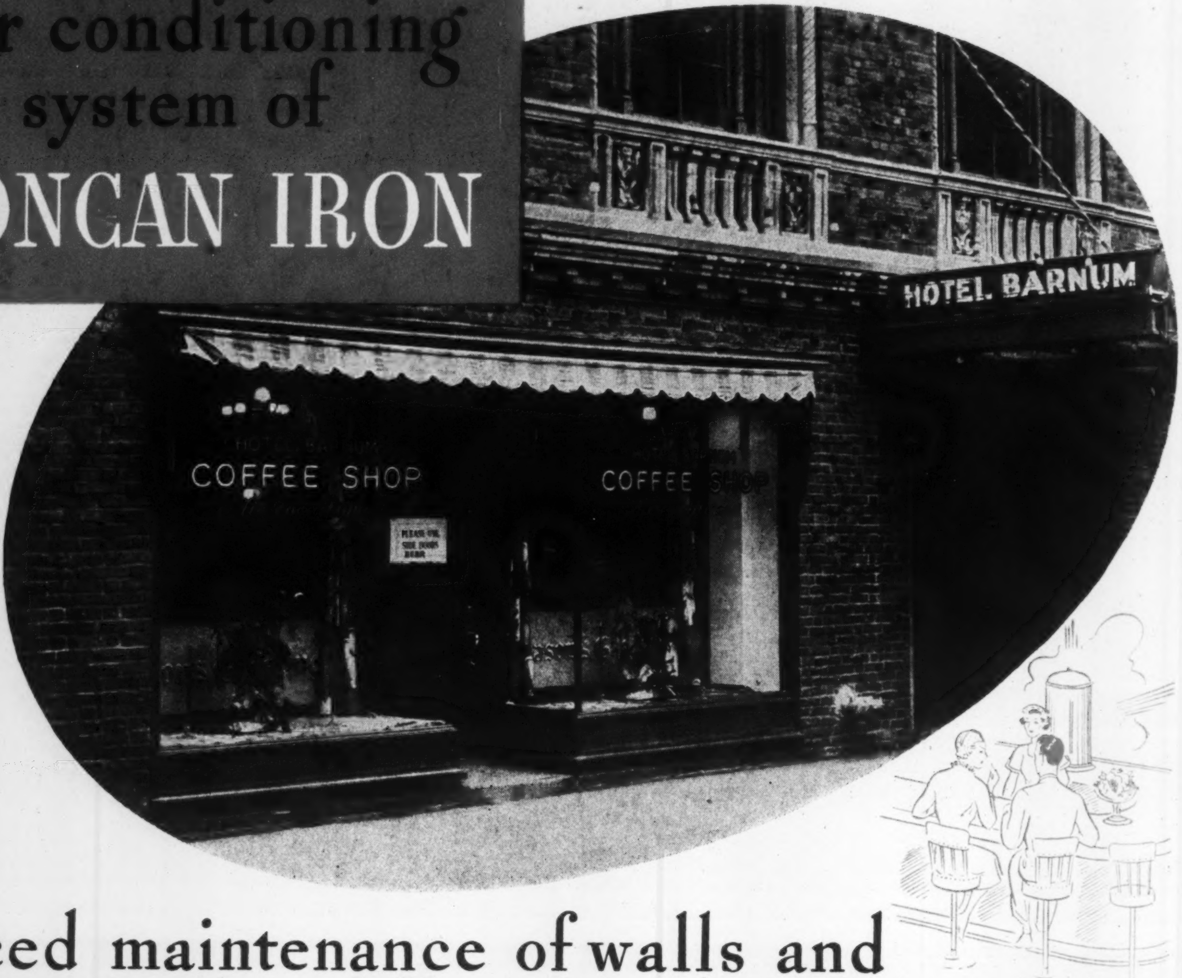
Ventilating Engineers

Air conditioning system of TONCAN IRON



reduced maintenance of walls and ceilings in this coffee shop by 90%

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COPPER
MO-LYB-DEN-UM
IRON

Republic produces a sheet for every degree of corrosion-resistance—plain carbon steel, copper-bearing steel, copper-bearing iron, Toncan Copper Molybdenum Iron and Enduro Stainless Steel

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• The advantages made possible by air conditioning are manifold—and they reflect most favorably in the earnings of commercial business that recognizes the value of modern air treatment.

Take Hotel Barnum in Bridgeport, Conn., as an example. A modern air conditioning system helped to stop deterioration of valuable mural paintings caused by fine particles of dust and soot. It reduced by 90% the cost of upkeep of painted walls and ceilings. And after two years of operation, a check-up revealed that increased patronage and savings in maintenance had almost paid for the air conditioning system. This installation has been so successful that the grill unit of the hotel is also being air conditioned.

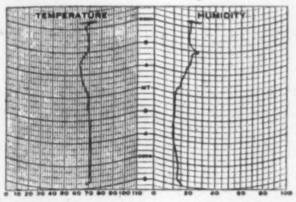
Further savings accruing from low maintenance of the duct system will tend to increase profits in the future—because the ducts are made of Toncan Iron. This alloy of refined open-hearth iron, copper and molybdenum possesses the greatest rust-resistance of any ferrous material in its price class—insures long trouble-free life and low cost for all types of service in which it is used for the sheet metal parts. It makes savings possible for the contractor, too, because of its ductility and ease of working.

Write for a copy of "The Path to Permanence"—it contains interesting facts and information on Toncan Iron.

When writing Republic Steel Corporation for further information, please address Department H. P.

THE EDITOR'S PAGE • October, 1936

■ **"Dry as the Desert"**—C. N. Bailey, chief engineer of the air conditioned Monroe-Dearborn building, Chicago, had read many times that the air in an unconditioned building in winter was "dry as the desert." To check up, he shut down the humidifying sprays on a day when the outside temperature was 10 F, took the record reproduced here on a portable temperature and humidity recorder. As will be noted, the relative humidity was but 10 per cent for several hours, went above 20 per cent only for a very short time.



■ **Corrosion Resistant Metals, $50 Million**—A symposium on corrosion resistant metals in design of machinery and equipment will be a feature of the annual meeting of the *American Society of Mechanical Engineers,* New York City, November 30 to December 4. Need for such a symposium has been expressed by designing and operating engineers constantly confronted with corrosion problems. Following an introduction by Dr. F. N. Speller of the National Tube Co., papers covering the following metals will be presented—alloys of aluminum, nickel and nickel-base alloys, zinc, lead, cast iron, copper and copper-base alloys, and corrosion resistant steel. . . . From 1932 to 1935 American railroads spent more than $50,000,000 to air condition and service approximately 6,000 passenger cars, according to L. W. Wallace, director of equipment research, *Association of American Railroads,* in a recent address. "Probably there has been no other procedure adopted by the railroad industry of greater importance than air conditioning," said Mr. Wallace. . . . Illinois' workmen's occupational disease act became operative October 1; employers who elect to operate under the act will pay employees for disabilities or death due to occupational disease amounts now paid under the workmen's compensation act for accidental injuries.

■ **Standardization** — The *American Standards Association,* 29 W. 39th St., New York City, has issued a list of new and revised American Standards which is available upon request. . . . A proposed standard for pipe plugs, giving dimensional specifications, has been submitted to the *A. S. A.* by the *American Society of Mechanical Engineers.* . . . The engineering and management aspects of industrial standardization will be taken up in a series of eight lectures to be given during October and November by Dr. John Gaillard, *A. S. A.* staff member and author of "Industrial Standardization, Its Principles and Application." The lectures are to be given at Rockefeller Center, New York City . . . Revisions in the standard specifications for carbon steel castings for valves, flanges and fittings for high temperature service, and the standard specifications for forged or rolled steel flanges for high temperature service have been submitted to the *A. S. A.* by the *American Society for Testing Materials.*

■ **Dentists, Churches, Training**—The advantages of air conditioning dentists' offices have been surveyed by *Oral Hygiene.* One hundred per cent of the dentists queried—and who have had experience with air conditioned offices—believed that air conditioning decreased the strain of operating work on the part of the dentist and added to the comfort of the patient. Some 40 per cent reported increased practice in summer months after installation of air conditioning equipment.

. . . According to the Commonwealth Edison Co., installation of an electrical room cooler in a Chicago dental laboratory has nearly doubled the working capacity of the laboratory, resulted in a more satisfactory finished product, and minimized waste. . . . According to an editorial in the October *Church Management,* modern engineering has accomplished two things which are distinct aids in the comfort and appreciation of worship—sound control and air conditioning. Few churches have an adequate air conditioning system now, but they must come to it, says the editorial. . . . According to *Church Management,* peculiar problems are offered in air conditioning churches; first of all, the sanctuary is in use but a few hours each week, which makes an investment in a full time system seem unnecessary. Secondly, few churches have competent engineering personnel to maintain and operate a system.

. . . S. Lewis Land writes on apprenticeship and apprentice training, journeymen training and other types of training programs in the heating, piping and air conditioning industry in the September "Official Bulletin" of the *Heating, Piping and Air Conditioning Contractors National Association.*

■ **Serving the Customer**—According to Hortense M. Dominici, President, Bonwit Teller, Inc., of New York City (in the September issue of the *Executives Service Bulletin,* published by the Metropolitan Life Insurance Co.), air conditioning is of prime importance in catering to the comfort of customers.

■ **Miniature Steel Works, Tin Can Tourists, Food Sales**—A miniature steel works for developing the discoveries of its research engineers will be constructed by the Jones & Laughlin Steel Corp., it was announced last month. The midget plant will be equipped with actual steel making units capable of duplicating the operations in the big mills necessary to manufacture iron and steel. A new building will be constructed to house the "pilot plant" and the research staff. . . . Air conditioned tourist camps are the latest bid for the dollars of the so-called "tin can tourist." A system installed in Georgia has proved so successful that tourists make reservations in advance, according to Kelvinator Corp., whose equipment conditions eight cabins. . . . Kelvinator announced last month a $600,000 expansion program to permit a 25 per cent increase in capacity. Additional room for production of air conditioning equipment and domestic refrigeration units is planned. . . . Chicago Rotary Club No. 1, the first founded and the largest in the world, has installed air conditioning for its headquarters on the mezzanine floor of the Sherman Hotel; Kroeschell Engineering Co. made the installation, which has a cooling capacity of 8½ tons. Winter conditioning is provided for. . . . According to Westinghouse Electric & Mfg. Co., whose air conditioning equipment is used in the O. P. Skaggs Stores, Sioux City, Ia., summer food sales after air conditioning set new all time records.

. . All American Bus Lines, Inc., have developed an air conditioned sleeper bus.

■ **Conditioning Papers**—The value of the method proposed recently by the National Bureau of Standards for conditioning papers for optimum register in multicolor offset printing was demonstrated at the printing plant of the Coast and Geodetic Survey, which prints high quality maps by the offset process, some of which are printed in as many as 24 colors. Five thousand prints of a map on paper 32 by 48 in. in 13 colors were made without the loss of a single print due to faulty register, notwithstanding that several weeks elapsed between printing of the first and last colors. Details of the recommendations for conditioning papers may be found in the National Bureau of Standards Research Paper 859, "Treatment of Offset Papers for Optimum Register."

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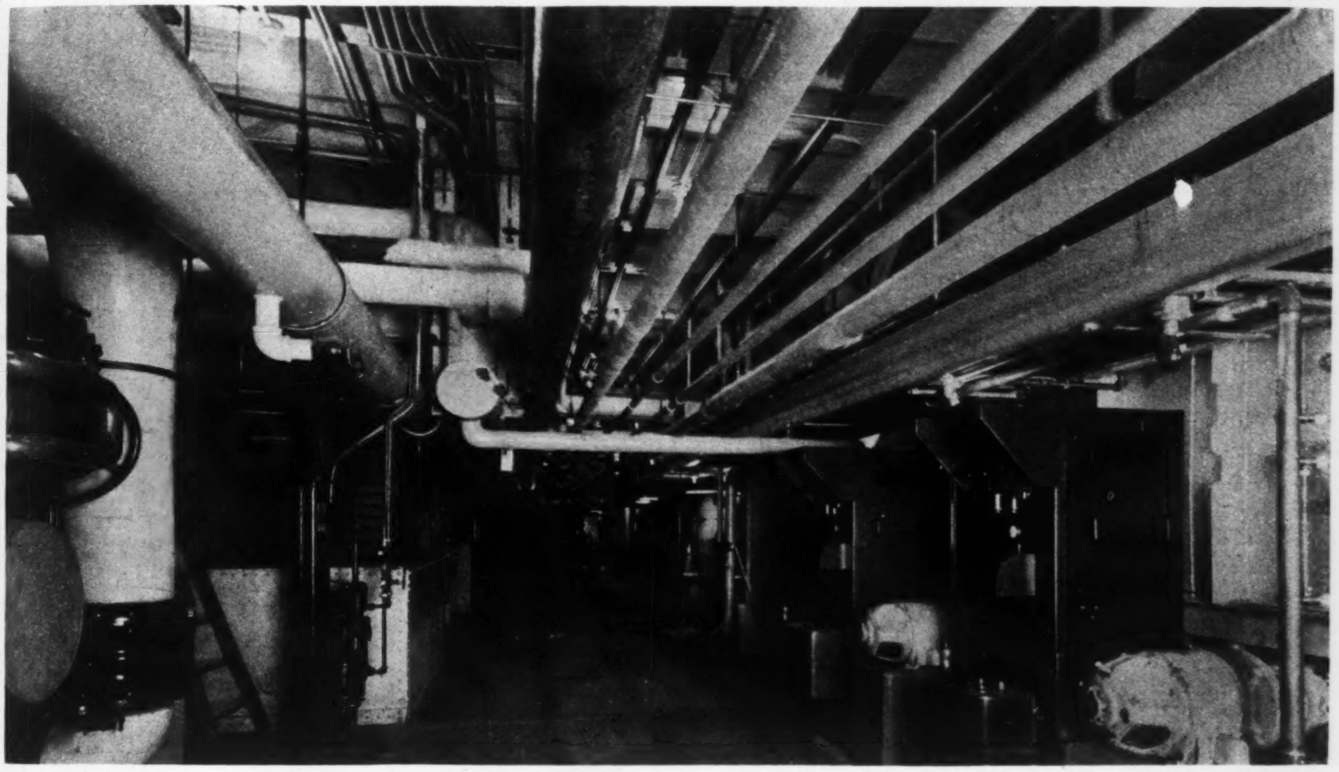
Heating·Piping
and Air Conditioning

Vol. 8, No. 10 ● *October, 1936*



Piping in condenser room, Conners Creek plant

Use of American Standard Pipe-Thickness Schedules

Part 1

By **Arthur McCutchan** *

THE American Standard for Wrought Iron and Wrought Steel Pipe was approved as a tentative standard by the *American Standards Association* in November, 1935. This standard contains tables of dimensions and nominal weights of pipe covering a wide range of service conditions. These tables are designed to meet the diversified needs of the piping industry with the smallest practicable number of pipe wall thicknesses in each size. The primary purpose of the standard is to reduce unnecessary duplication in the manufacture of pipe and particularly to effect a reduction in the pipe carried in jobbers' stocks to the extent that jobbers will find it possible to stock for immediate delivery the more commonly used grades of pipe in the thicknesses listed in the schedules. It is not the intent to rule out special thicknesses where the quantity of pipe desired warrants a special rolling at the mill, but rather to set up standard schedules to facilitate purchase of smaller lots of pipe. A table giving these schedule thicknesses was published in HEATING, PIPING AND AIR CONDITIONING, October, 1933, page 501.

The schedule numbers used in these tables approximate values of the expression $1000 \times P/S$. Thus Schedule 40 is roughly suitable for a service pressure of 400 lb per sq in., provided an allowable stress of 10,000

---

*Engineer, Engineering Division, The Detroit Edison Co., Detroit, Mich.

The schedules of pipe wall thicknesses of the American Standard for Wrought Iron and Wrought Steel Pipe—approved as a tentative standard last November—are described and their use explained. An example showing the method of selection of the schedule of pipe thickness is given, and tables of the dimensional properties of pipe used in computing steam and water velocities, pressure drops and flexural characteristics of pipe lines are presented. . . . The second part of this article will describe piping design problems for which these tables can be used to particular advantage, and will include similar tables for other schedules.

lb per sq in. is satisfactory for the particular pipe material under the type of service and temperature conditions involved.

The preface to this standard for pipe thickness states that it is intended the user will compute the theoretical wall thickness as described in detail in the *A.S.M.E.* Boiler Code, the American Tentative Standard Code for Pressure Piping (*A.S.A.* B31-1935) or similar codes. And, that the value of allowable bursting stress to be used in such computation is to be obtained from the code or design rules selected. The nominal schedule thickness which corresponds most nearly to this computed thickness, after making proper allowance for under-thickness mill tolerance, is then selected.

In order to avoid the appearance of complexity, it should be emphasized that for the general run of low pressure uses where "standard weight" and "extra strong" pipe are traditionally employed, computation of the wall thickness is unnecessary. The pipe wall thicknesses corresponding to "standard weight" and "extra strong" pipe are given in bold face type in Schedule 40 and Schedule 80, respectively, of the American Standard for Wrought Iron and Wrought Steel Pipe.

It seems desirable to point out that the formula given in the preface to this standard, which was used in establishing consistent pipe wall thickness schedules, differs somewhat from the formulas intended for use in design. The following formula, given in the *A.S.A.* Code for Pressure Piping, B31-1935, is satisfactory for general design purposes.

$$t_{min} = \frac{PD}{2S} + C$$

where

t_{min} = minimum pipe wall thickness allowable on inspection, inches.
P = maximum internal service pressure, lb per sq in.
D = outside diameter of pipe, inches.
S = allowable bursting stress in material, lb per sq in.
C = allowance for threading, mechanical strength, and/or corrosion, inches.

The value of C is required to be not less than that given in Table *A,* which has been compiled from the several sections of the 1935 version of the Code for Pressure Piping.

The value of allowable stress S for a number of classes of carbon steel pipe for different service conditions as given in the 1935 version of the Code for Pressure Piping is given in Table B.

Additional requirements in the use of this formula for determining pipe wall thicknesses for all these classes of service are that pipe lighter than Schedule 40 shall not be threaded and that the value of P shall not be taken

Table A—Allowance for Threading, Mechanical Strength and/or Corrosion
Values of C, Inches

	POWER PIPING SYSTEMS AND DISTRICT HEATING PIPING	GAS AND AIR PIPING	OIL PIPING
Threaded steel, wrought iron or non-ferrous pipe	Depth of thread[1]	Depth of thread[1]	Depth of thread[1]
Grooved steel, wrought iron or non-ferrous pipe	Depth of Groove	Depth of Groove	Depth of Groove
Plain end[2] steel, wrought iron or non-ferrous pipe or tube for 1 in. size and smaller	0.05	0.02	0.05
Plain end[2] steel, wrought iron or non-ferrous pipe or tube for sizes above 1 in.	0.065	0.05	0.05

Similar values of C for cast iron pipe are given in the Code.

[1] The depth of thread for American Standard Taper Pipe Threads is tabulated below.

NOMINAL PIPE SIZE, IN.	NO. THREADS PER IN.	DEPTH OF THREAD, IN.	NOMINAL PIPE SIZE, IN.	NO. THREADS PER IN.	DEPTH OF THREAD, IN.
⅛	27	0.02963	1 to 2, incl.	11½	0.06956
¼ and ⅜	18	0.04444	2½ to 30, incl.	8	0.10000
½ and ¾	14	0.05714			

[2] Plain end pipe includes pipe joined by flared couplings, van stoned joints and by welding or other method which does not reduce the wall thickness of the pipe.

Table B—Allowable S Values for Steel Pipe[1]

	POWER PIPING SYSTEMS AND DISTRICT HEATING PIPING						GAS AND AIR PIPING		OIL PIPING		
										WITHIN REFINERY LIMITS	OUTSIDE REFINERY LIMITS
	Spec.	450 F	700 F	750 F	800 F	850 F	Spec.		Spec.	750 F	100 F
Seamless Steel											
Grade A	A.S.T.M. A106	(11,250)	9,600	9,000	7,020	5,800	A.S.T.M. A53	16,000	A.S.T.M. A106	12,000	24,400
Grade B	A.S.T.M. A106		12,400	11,500	9,160	7,520	A.S.T.M. A53	20,700	A.S.T.M. A106	15,500	31,500
									A.P.I. 5L	15,000	30,500
Electric Resistance Welded											
Grade A	A.S.T.M. A135		8,200	7,600			A.S.T.M. A135	13,600	A.P.I. 5L	10,200	20,700
Grade B	A.S.T.M. A135		10,200	9,500			A.S.T.M. A135	17,000	A.P.I. 5L	12,750	25,900
Lap-Welded Steel	A.S.T.M. A106 A.S.T.M. A120	7,600	7,600	7,000			A.S.T.M. A53 A.S.T.M. A120	12,000	A.P.I. 5L	9,000	18,300
Butt-Welded Steel	A.S.T.M. A53 A.S.T.M. A120	6,000	6,000	5,600			A.S.T.M. A53 A.S.T.M. A120	10,000	A.S.T.M. A53 A.P.I. 5L	7,500	15,200

[1] For complete table, see Code for Pressure Piping. A similar tabulation based on the 1933 draft of the Code was published in HEATING, PIPING AND AIR CONDITIONING, February, 1934, page 57.

Table 1—Properties of Schedule 40 Pipe

Conforming to *A. S. A.* Standard B36.10 for Wrought Iron and Wrought Steel Pipe

Nominal Pipe Size in.	Outside Diam in. D	Wall Thick-ness in. t	Inside Diam in. d	Inside Diam Squared d^2	Inside Diam Fifth Power d^5	Area of Metal Sq In.	Internal Cross-Sectional Area Sq In.	Internal Cross-Sectional Area Sq Ft [1]	External Surface Per ft Sq Ft	Moment of Inertia in.^{4}	Weight of Pipe Per ft Lb	Weight of Water Per ft of Pipe Lb
1/8	0.405	0.068	0.269	0.0724	0.00141	0.072	0.0569	0.00040	0.106	0.001064	0.25	0.0250
1/4	0.540	0.088	0.364	0.1325	0.00639	0.125	0.1041	0.00072	0.141	0.003312	0.43	0.0449
3/8	0.675	0.091	0.493	0.2430	0.02912	0.167	0.1909	0.00133	0.177	0.007291	0.57	0.0830
1/2	0.840	0.109	0.622	0.3869	0.09310	0.250	0.3039	0.00211	0.220	0.01709	1.86	0.1317
3/4	1.050	0.113	0.824	0.679	0.3799	0.333	0.5333	0.00371	0.275	0.03704	1.14	0.2315
1	1.315	0.133	1.049	1.100	1.270	0.494	0.8639	0.00600	0.344	0.08734	1.68	0.3744
1 1/4	1.660	0.140	1.380	1.904	5.005	0.669	1.495	0.01040	0.435	0.1947	2.28	0.6490
1 1/2	1.900	0.145	1.610	2.592	10.82	0.799	2.036	0.01414	0.497	0.3099	2.72	0.8823
2	2.375	0.154	2.067	4.272	37.72	1.075	3.356	0.02330	0.622	0.666	3.66	1.454
2 1/2	2.875	0.203	2.469	6.096	91.75	1.704	4.788	0.03322	0.753	1.530	5.80	2.073
3	3.5	0.216	3.068	9.413	271.8	2.228	7.393	0.05130	0.916	3.017	7.58	3.201
3 1/2	4.0	0.226	3.548	12.59	562.2	2.680	9.888	0.06870	1.047	4.788	9.11	4.287
4	4.5	0.237	4.026	16.21	1,058	3.173	12.73	0.08840	1.178	7.233	10.8	5.516
5	5.563	0.258	5.047	25.47	3,275	4.304	20.01	0.1390	1.456	15.16	14.7	8.674
6	6.625	0.280	6.065	36.78	8,206	5.584	28.89	0.2006	1.734	28.14	19.0	12.52
8	8.625	0.322	7.981	63.70	32,380	8.396	50.03	0.3474	2.258	72.49	28.6	21.68
10	10.75	0.365	10.02	100.4	101,000	11.90	78.85	0.5475	2.814	160.7	40.5	34.16
12	12.75	0.406	11.938	142.5	242,470	15.77	111.93	0.7773	3.338	300.3	53.6	48.50
14 OD	14.0	0.437	13.126	172.3	389,638	18.61	135.32	0.9397	3.665	429.1	63.3	58.64
16 OD	16.0	0.500	15,000	225,0	759,375	24.35	176.72	1.2272	4.189	731.9	82.8	76.58
18 OD	18.0	0.562	16.876	284.8	1,368,820	30.79	223.68	1.5533	4.712	1172	105	96.93
20 OD	20.0	0.593	18.814	354.0	2,357,244	36.15	278.00	1.9305	5.236	1703	123	120.46
24 OD	24.0	0.687	22.626	511.9	5,929,784	50.31	402.07	2.7921	6.283	3424	171	174.23

Underscored wall thicknesses are identical with thicknesses for "standard weight" pipe in former tables.

[1] This column also represents the contents in cu ft per ft of length.

Table 2—Properties of Schedules 10, 20 and 30 Pipe

Conforming to *A. S. A.* Standard B36.10 for Wrought Iron and Wrought Steel Pipe

Nominal Pipe Size In.	Outside Diam In. D	Wall Thick-ness In. t	Inside Diam In. d	Inside Diam Squared d^2	Inside Diam Fifth Power d^5	Area of Metal Sq In.	Internal Cross-Sectional Area Sq In.	Internal Cross-Sectional Area Sq Ft[1]	External Surface Sq Ft	Moment of Inertia In.^{4}	Weight of Pipe Per Ft Lb	Weight of Water Per ft of Pipe Lb
SCHEDULE - 10												
14 OD	14.0	0.250	13.50	182.25	448,403	10.80	143.14	0.994	3.665	255.3	36.8	62.03
16 OD	16.0	0.250	15.50	240.25	894,660	12.37	188.69	1.310	4.189	383.7	42.1	81.74
18 OD	18.0	0.250	17.50	306.25	1,641,309	13.94	240.53	1.670	4.712	549.1	47.4	104.21
20 OD	20.0	0.250	19.50	380.25	2,818,312	15.51	398.65	2.768	5.236	756.4	52.8	172.72
24 OD	24.0	0.250	23.50	552.25	7,166,695	34.36	533.74	3.706	6.283	1,315.0	63.5	231.25
30 OD	30.0	0.312	29.376	862.95	21,875,285	29.10	777.76	5.401	7.854	3,206.0	99.0	337.02
SCHEDULE - 20												
8	8.625	0.250	8.125	66.02	35,409	6.57	51.85	0.3601	2.258	57.72	22.4	22.47
10	10.75	0.250	10.25	105.06	113,141	8.24	82.52	0.5731	2.814	113.7	28.1	35.76
12	12.75	0.250	12.25	150.06	275,855	9.82	117.86	0.8185	3.338	191.8	33.4	51.07
14 OD	14.0	0.312	13.376	178.92	428,185	13.42	140.52	0.975	3.665	314.4	45.7	60.89
16 OD	16.0	0.312	15.376	236.42	859,442	15.38	185.69	1.290	4.189	473.2	52.3	80.50
18 OD	18.0	0.312	17,376	301.92	1,583,978	17.34	237.13	1.647	4.712	678.2	59.0	102.77
20 OD	20.0	0.375	19.25	370.56	2,643,344	23.12	290.04	2.014	5.236	1113	78.6	125.67
24 OD	24.0	0.375	23.25	540.56	6,793,832	27.83	424.56	2.948	6.283	1942	94.7	183.95
30 OD	30.0	0.500	29.00	841.0	20,511,149	46.34	660.52	4.587	7.854	5,042	158	286.23
SCHEDULE - 30												
8	8.625	0.277	8.071	65.14	34,248	7.26	51.16	0.3553	2.258	63.35	24.7	22.17
10	10.75	0.307	10.136	102.74	106,987	10.07	80.69	0.5603	2.814	137.4	34.3	34.96
12	12.75	0.330	12.09	146.17	258,304	12.87	114.80	0.7972	3.338	248.4	43.8	49.74
14 OD	14.0	0.375	13.25	175.56	408,394	16.05	137.88	0.9575	3.665	372.8	54.6	59.75
16 OD	16.0	0.375	15.25	232.56	824,801	18.41	182.65	1.268	4.189	562.1	62.6	79.12
18 OD	18.0	0.437	17.126	293.30	1,473,261	24.11	230.36	1.600	4.712	930.3	82.0	99.84
20 OD	20.0	0.500	19.0	361.00	2,476,099	30.63	283.53	1.969	5.236	1,457	105	122.87
24 OD	24.0	0.562	22.876	523.31	6,264,703	41.39	411.00	2.854	6.283	2,843	141	178.09
30 OD	30.0	0.625	28.75	826.56	19,642,160	57.68	649.18	4.508	7.854	6,224	197	281.30

Underscored wall thicknesses are identical with thicknesses for "standard weight" pipe in former tables.

[1] This column also represents the contents in cu ft per ft of length.

at less than 100 lb per sq in. gauge for any conditions or material. In the case of gas and air piping to be buried beneath streets the minimum value of P is given as 185 lb per sq in. gauge. It also is required that where steel pipe is threaded and used in power piping systems for steam pressure in excess of 250 lb per sq in. or water over 125 lb per sq in. and 220 F the pipe shall be seamless of a quality at least equal to *A.S.T.M.* A106 and of a weight at least equal to Schedule 80 in order to furnish additional mechanical strength. Seamless pipe of Schedule 80 thickness and of a quality equal to *A.S.T.M.* A106 is also required for threaded construction in district heating piping if the steam pressure exceeds 125 lb per sq in. or water is at 220 F or higher and/or a pressure over 175 lb per sq in. Only seamless carbon steel pipe or a seamless high temperature resisting alloy pipe is permitted in oil piping systems above 750 F.

For all ordinary low pressure and low temperature services where threaded pipe is used, the foregoing requirements automatically dictate use of Schedule 40 pipe, which in sizes 10 in. and smaller conforms to the old "standard weight" dimensions. Consequently no calculation of pipe thickness is necessary. In selecting pipe for van stoned or welded construction, however, the minimum thickness on inspection must in general be computed and the schedule selected which will allow for the 12½ per cent under-thickness mill tolerance.

Example Shows Selection of Pipe Thickness Schedule

An example showing the selection of the schedule of pipe thickness suitable for the superheated steam lines of a power piping system should clarify this calculation of pipe thickness. Assume steam conditions are 380 lb per sq in. gauge, 700 F, and that it is desired to find the proper schedule of pipe thickness for a 16 in. O.D. van stoned line using Grade A seamless pipe conforming to *A.S.T.M.* Spec. A106. The minimum thickness on inspection is found from the formula

$$t_{\min} = \frac{PD}{2S} + C$$

where, (in this case)

$P = 380$ lb per sq in. gauge

$D = 16$ in.

$C = 0.065$ in. as given in Table A for plain end pipe

$S = 9{,}600$ lb per sq in. for Grade A pipe of *A.S.T.M.* A106 at 700 F as given in Table B.

$$t_{\min} = \frac{380 \times 16}{2 \times 9{,}600} + 0.065$$

$$t_{\min} = 0.3816 \text{ in.}$$

The least nominal thickness allowing for a 12½ per cent under-thickness mill tolerance would therefore be 0.3816/0.875 = 0.437 in. The nearest heavier schedule thickness is 0.500 in., which is Schedule 40. With the exception of the smaller pipe sizes which if threaded require Schedule 80 pipe it will be found that Schedule 40 is suitable for all the pipe sizes which may be used in the superheated steam system of this particular plant. This follows from the fact that schedule numbers represent consistent relations between the working pressure and the allowable stress. It is not recommended, however, that the wall thickness be computed for merely one pipe size and the assumption made that for the same service conditions, wall thickness can be selected indiscriminately from the corresponding schedule. The wall thickness for each pipe size should be computed individually and the correct wall thickness chosen from the tables. As mentioned previously, the schedules only *approximate* values of the expression $1000 \times P/S$.

Tables of Properties of Pipe Prepared

Since a single schedule of pipe wall thicknesses may cover the entire range of pipe sizes in a given service, the dimensional properties of pipe used in computing steam and water velocities, pressure drops and flexural characteristics of the lines can be conveniently grouped in tables for each schedule number. A series of tables giving the properties of pipe most commonly required in making such calculations has been prepared covering the schedule numbers from 10 to 160, inclusive. Because the lower schedule numbers do not extend below the 8 in. pipe size and because Schedule 40, which corresponds to "standard weight" pipe in sizes 10 in. and smaller, is considered one of the basic schedules it is presented as Table 1. Table 2, covering pipe lighter than Schedule 40, sometimes referred to as "thin wall" pipe, gives the properties of Schedules 10, 20 and 30 pipe.

It is probable that these lighter schedules will be extended to the smaller pipe sizes when the advantages of welded construction are more fully realized as was pointed out by Mr. F. L. Snyder in the August, 1935, HEATING, PIPING AND AIR CONDITIONING, but at the present time designing engineers hesitate to use pipe which in some cases is less than half as heavy as "standard weight" pipe even when due cognizance is taken of the elimination of threads.

The second part of this article will describe some of the problems of piping design for which these tables can be used to particular advantage and will present similar tables for the basic schedules 80, 120 and 160 and the intermediate schedules 60, 100 and 140.

Boiler Header Connections

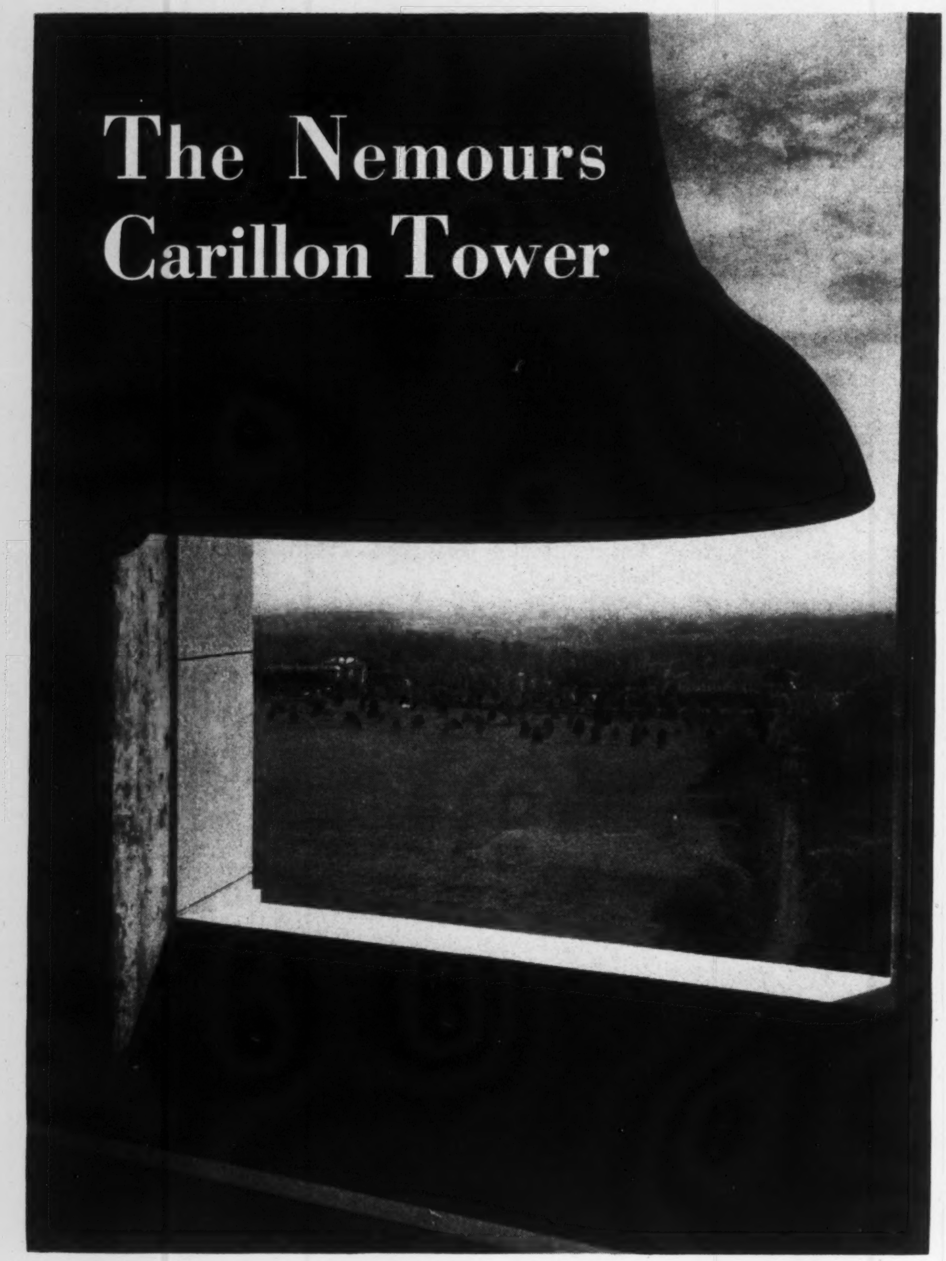
It is imperative that all steam flow openings in the steam boiler (not so in hot water boilers) be used full size and not bushed down. By using all flow openings full size, the velocity of steam from the boiler will be at a safe rate, and boiler will not have a tendency to prime water with the steam flow, unless a dirty water condition exists.

The size of the horizontal header for the flow outlets should be at least equal to the size of the flow outlets. *Example:* If the boiler has three 3 in. flow outlets, make horizontal header 3 in. size.

Exception: If the total area of the supply main or mains exceeds the area of the flow outlets, the horizontal header should be one pipe size larger than the total area of the supply main or mains. *Example:* If a boiler has 4 in. flow outlets and is connected to a 5 in. steam main, the horizontal header size should be 6 in.

Data may be applied to any job where the total sq ft of E D R radiation load does not exceed 4000. Data pertains only to low pressure steam boilers.—HAROLD J. TAYLOR, *Contracting Engineer.*

The Nemours Carillon Tower



(*Photograph on front cover*)

ANCIENT tablets unearthed in Mesopotamia illustrate the use of towers in Assyrian fortifications as early as 2700 B.C. The tower's origin lies far back in the dim beginnings of man's architectural effort, and in time it became a symbol of security and of human aspiration. Naturally we find it a prominent feature in many of the finest examples of secular and ecclesiastical buildings.

The history of bells also is full of romance and human interest. As symbols of authority they early served as a call to arms, and in times of war a conqueror often melted down the bells of a captured city to prevent their use as a rallying call for revolt by the subject peoples. Bells have signalized every kind of human experience—death, disaster, joy, religious fervor.

Consequently, bells—like towers—have come to have a special significance, and the two have become associated in the human mind. Bells have had a marked influence on architecture, and have inspired the creation of some of the most famous towers in the world. The strength and beauty of a graceful tower form a fitting association for the music of bells, and the combination gives joy and inspiration through both eye and ear.

The late Alfred I. duPont, in seeking a suitable memorial to his mother and father, determined upon the campanile, or bell tower, as an ideal type of structure. Containing crypts for family burial, it would also give pleasure to the public by its architectural beauty and the musical excellence of its bell chimes. The site selected was a piece of high ground on Mr. duPont's estate, Nemours, overlooking Wilmington, Delaware, and the Delaware river from the west. The architects, Massena & duPont, were commissioned to determine the most appropriate design of tower for the location selected. The spire of the old church at Nemours, France, was first studied because ancestors of Mr. duPont had lived there, but it was found to be unsuited for the purpose. An original design was therefore created combining rare classical beauty with simplicity of design, line and proportion, in perfect harmony with the surroundings. The result is a splendid memorial to a distinguished family and to the genius of the architects.

The foundations go down to solid bed rock. There are underground rooms, the walls of which rise in a square base of heavy native stone and form a terrace 7 ft above the ground. Flights of steps rise to this on each side of the square. From the center of this spacious terrace the shaft of the tower rises majestically. Although square in form, its corners are chamfered and a slight taper upward gives a sense of slim grace combined with strength. Below the cornice at the first floor level the walls are finished in gray Vermont granite. Above that is cast stone, the corners being gray of the same color and texture as the granite base and the panels a delicate pink. This cast stone has a bush hammered finsh.

A belfry surmounts the main shaft and is crowned by a delicate, tapering spire tipped by a bronze cross. The belfry is octagonal with eight graceful arches separated only by slender pilasters. Just beneath the base of the belfry is a cornice and stone balustrade surrounding an observation walk. At the four corners are heroic figures of American eagles. On four sides at the top are aerial beacon lights which add an interesting illumination effect. Sauter & Schwertner of Philadelphia were the general contractors for the tower.

An unusual feature of the structure is its monolithic design, without a structural steel frame. The exterior wall of precast stone was set in permanent position and an interior form built of wood. Reinforcing bars were placed and concrete poured to form a massive interior wall securely bonded to the cast stone exterior. The cast stone units average about 8 ft long by 4 ft wide and 5 in thick, and weigh approximately 1,800 lb each. The sectional steel scaffolding was the same that was constructed for the recent cleaning and repair of the Washington Monument.

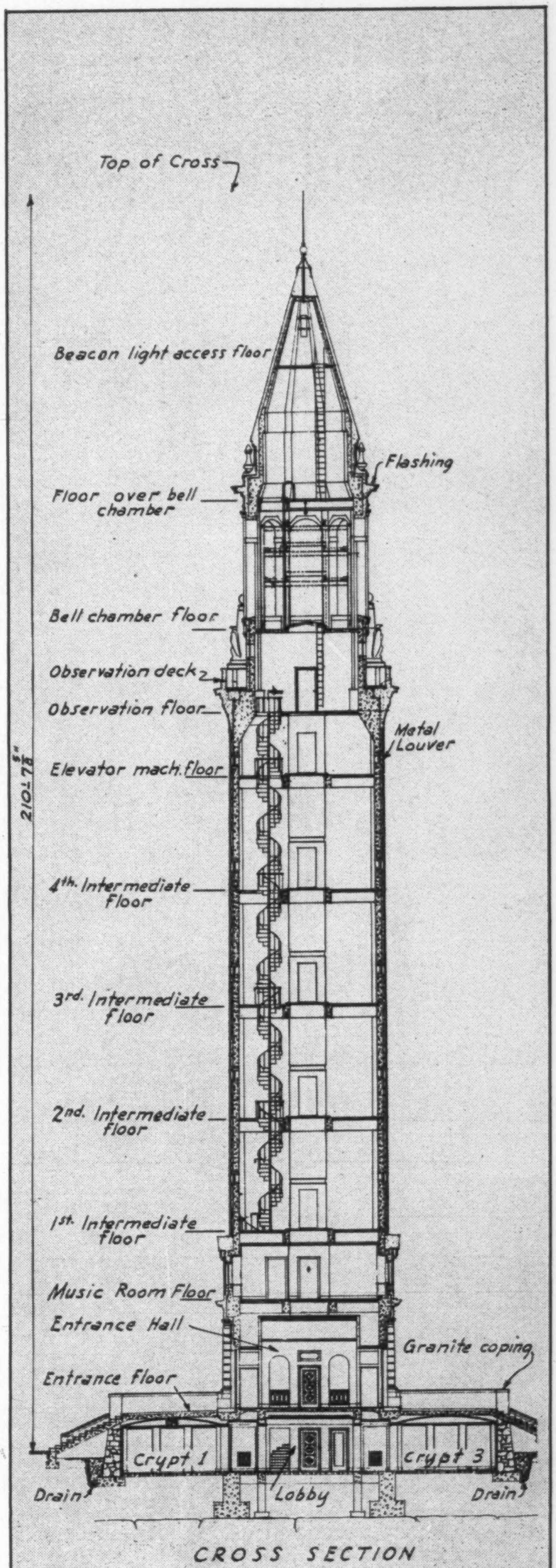
At opposite sides of the tower bronze doors lead from the terrace into the entrance hall. This room is utterly simple, with marble walls, floor and window seat. In the wall are recessed electric heating and air circulating units hidden behind bronze plates and grilles. A bronze door to the elevator shaft faces an arched window, and a stone stairway descends to the rooms below, while an enclosed spiral metal stair leads upward.

[*By* Lee P. Hynes *]

Underneath the entrance hall are three burial crypts forming three wings of a cross, each crypt being closed by simple bronze gates each bearing a small cross. These rooms are also heated by recessed electric heating and air circulating units behind bronze grilles. Back of the elevator shaft a fourth room houses the main electrical apparatus and forms an underground substation to supply the building with the various types of electric power which are required.

Above the entrance hall is the music room, where the musician's keyboard, from which the bell chimes are played by remote electric control, is situated. Just beneath the belfry is a room housing the elevator machinery and switchboards controlling the electrical operation of the bells. In the belfry a steel structure carries 30 bells varying in weight from 30 to 5,600 lb. The bells are stationary, clappers being swung by electric solenoids controlled from the keyboard in the music room. These bronze bells were cast and tuned in the old Meneely Bell Foundry at Watervliet, N. Y. Inside the tip of the spire is a small conical room for servicing the beacon lights which are set in its walls.

Because of the character of the tower structure and in keeping with the desire to have every detail of the type most suited to the service, electricity was selected for all heating, lighting and power purposes. Primary power of 2,400 volts, 3 phase, 60 cycle is purchased from the Delaware Power & Light Co. and brought two miles over a private overhead pole line. At the edge of the tower grounds, the line drops down into conduit and runs underground to the substation in the tower base. Here the 2,400 volts is distributed to four transformers totaling 100 kva capacity. These supply groups of circuits at 115 and 230 volts, single and 3 phase as required. These circuits are distributed through the building in conduits,


Top of Cross
Beacon light access floor
Flashing
Floor over bell chamber
Bell chamber floor
Observation deck
Observation floor
Metal Louver
Elevator mach. floor
210'-7 5/8"
4th. Intermediate Floor
3rd. Intermediate floor
2nd. Intermediate floor
1st. Intermediate floor
Music Room Floor
Entrance Hall
Granite coping
Entrance Floor
Crypt 1
Crypt 3
Drain
Lobby
Drain
CROSS SECTION

Cross-section of Nemours Carillon Tower

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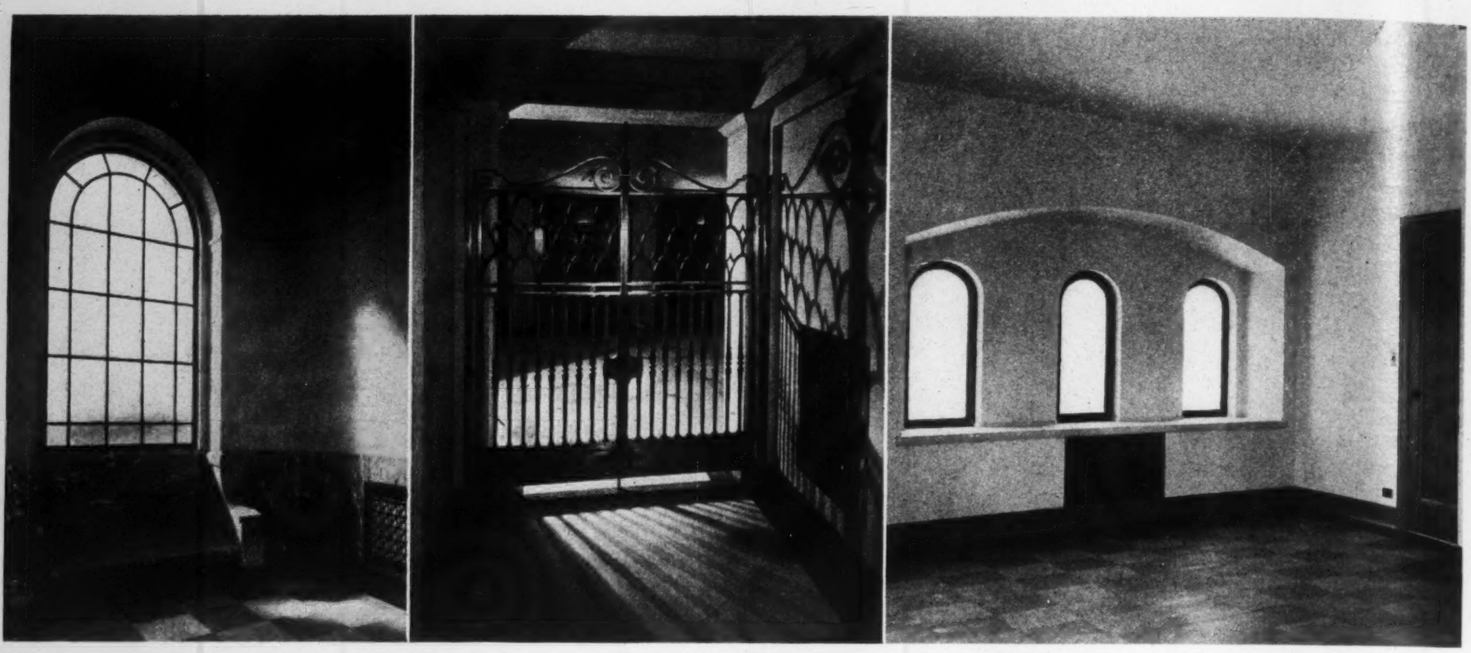
* Consulting Engineer, Philadelphia, Pa. Member of Board of Consulting and Contributing Editors.



Left to right—**The entrance hall, showing recessed heating and ventilating unit at right . . . . . Entrance to one of the burial crypts, showing recessed electric heating and ventilating unit at right . . . . . The music room, with heating unit under window**

and wherever these are embedded in concrete everdur metal was used for permanence.

Unique Heating Problems Involved

Some unique heating problems were presented. As the tower is not continuously occupied, it is not necessary to maintain a uniform temperature at all times, but a certain amount of heat is required at different locations for the protection of water pipes, to prevent condensation, to keep certain machinery warm enough to operate properly and to keep the rooms comfortable for the caretaker in making his inspections and carrying out his regular duties. At times when groups of people are present, certain rooms such as the music room or the family burial crypts may require heating to a normal room temperature, and it may be necessary to raise the temperature to the proper point in a comparatively quick time, as such visits are often made on rather short notice.

A careful study was made of the various heat requirements and the available methods of supplying them. Electricity was selected because of its absolute cleanliness, quiet, automatic operation, and because any sort of a chimney or flue for products of combustion would be impractical in a building of this character. A further advantage is the ease with which local temperature regulation in various parts of the building can be accomplished.

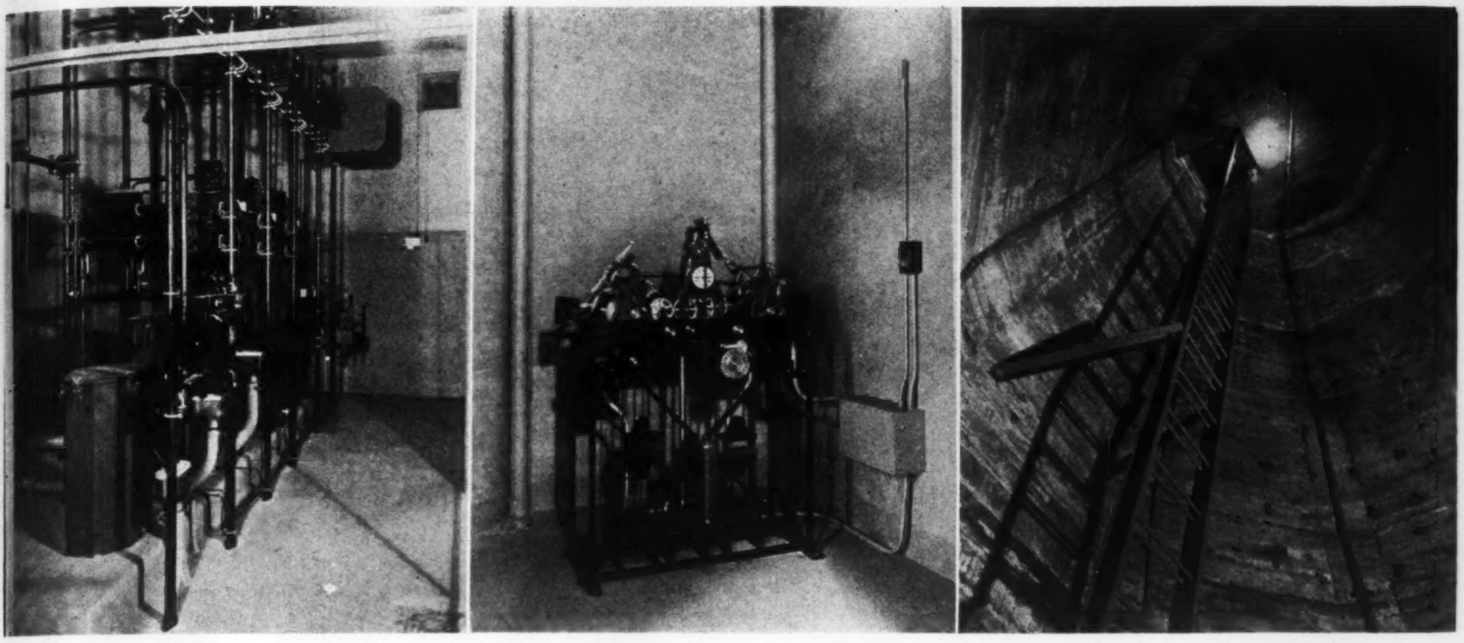
It was decided that the heaters should be recessed in the walls and a special design was worked out with a motor driven blower operating at low speed to insure extreme quiet. Air is drawn in through the top portion of the bronze grille back and down over the motor, through the multivane blower wheel and up through a plenum chamber, then down through a heater chamber behind a solid bronze plate. The warm air is finally discharged at the bottom through the grille near the floor line. This arrangement insures good circulation, uniform heating, overcomes cold floors, improves ventilation, and prevents the formation of condensation. The temperature of each room is controlled independently by a thermostat; each room is also under master remote control by means of manual switches located in a closet adjacent to the entrance hall.

Special Insulation Treatment

Special treatment was required for certain rooms (such as the music room) where it is necessary quickly to bring the temperature up to 70 degrees for the comfort of visitors and the musician playing on the keyboard of the carillon. Owing to the very massive concrete and stone walls a serious problem of heat storage was involved. While the thermal loss through the wall is not excesive, the heat absorption by the walls would seriously retard the rate of heating up the room. This was overcome by lining the interior walls and ceilings of such rooms with 2 in. corkboard placed between the wall and the interior plaster finish. Corkboard was also laid on the supporting concrete underneath the floors.

This cork insulation is thus interposed as a barrier between the mass of the wall structure and the room interior, leaving only the air of the room and the interior finish to be heated up quickly. This construction solved the problem perfectly, greatly reduced the total thermal loss, and furthermore added a desirable sound insulation to prevent reverberations from the bells. In some locations, as in the burial crypts where the arched ceilings tended to cause echoes and distort voices, perforated sound absorbing material was applied to the ceilings. This successfully solved the acoustic problems.

The heating system was installed early in November, 1935, and kept in operation constantly through the unusually severe winter which followed. During this time



Left to right—**Underground substation with dewpoint control on far wall which regulates electric heater to prevent condensation . . . . . Electric time clock which controls chimes and other automatic operations of the carillon bells . . . . . Interior of spire above belfry looking up toward room where beacon lights are serviced; note lightning protection cables at the corners**

the building was under construction and some of the doors and windows were closed only with temporary wooden or building paper barriers. However, comfortable temperatures were maintained for the men working on the interior finish and the building was dried out and condensation was prevented.

Dewpoint Control Prevents Condensation

In the substation room some waste heat is given off by the transformers and regulating coils, but a fan circulation electric heater was also installed to supply additional heat as required and to insure the thorough air circulation which is necessary to prevent local condensation on the cooler portions of walls and equipment. For economy in current consumption and for protection against condensation, this fan circulation electric heater is controlled by a special automatic instrument known as dewpoint control, which is shown in one of the photos. This instrument has an outdoor bulb located on the exterior side of the ventilating shutters at the window, where it is exposed to outdoor air temperatures, and an indoor bulb subject to the interior temperature.

These two bulbs work in conjunction with each other and produce a resultant differential temperature control. They do not maintain a constant temperature in the substation, but they keep the room about 15 degrees warmer than outdoor temperatures, between the limits of 35 and 65 F, preventing the forming of condensation. The effectiveness of this method was clearly demonstrated because, owing to a delay in getting the dewpoint instrument installed, the first cold spell was encountered without its being in operation and the substation walls and ceiling were soon dripping with moisture of condensation. As soon as the control and heater were hooked up, this moisture disappeared and no further trouble has been experienced.

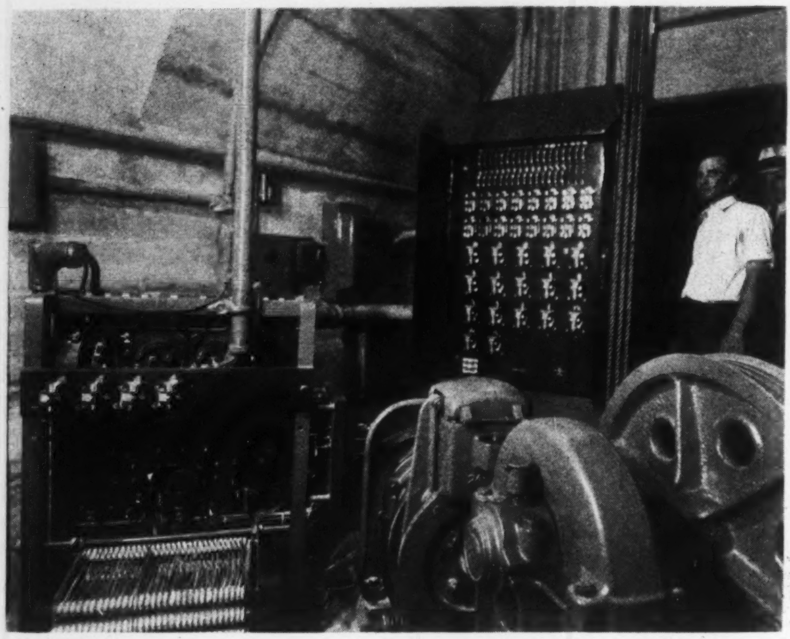
The installation of the heating equipment was also delayed in the room underneath the belfry where the elevator machinery and the carillon switchboards are situated. The extreme cold solidified the grease in the elevator machine gear cases so that proper operation was interfered with. As soon as a heater was installed with automatic control to keep the temperature in this room at about 50 F the trouble was overcome.

Ventilation of the underground rooms is by means of electric exhaust fans discharging into ducts constructed in the walls and leading to outlets protected by shutters. All such openings are carefully screened to prevent birds or small animals getting in where they might come in contact with the high voltage bus bars in the substation and short circuit them. While the walls and floors of the underground rooms were thoroughly waterproofed, a sump well was built as an additional precaution with an electric pump operated by a float switch.

Electrical Features

Floodlighting has been provided for so that the four wall faces of the main tower can be beautifully illuminated at night. At each of the four corners of the terrace are situated in the masonry wall six flush, waterproof, electric outlet boxes. Set in the floor of the terrace are sockets for supporting powerful floodlights which are connected by cable and plug to the wall outlets. The floodlight circuits are controlled by magnetic switches mounted on a panel in the substation room. These in turn are operated by remote control from four manual pilot switches in the control closet adjacent to the entrance hall.

Lightning protection is very important for a tall structure of this kind and the methods worked out for the protection of the Washington Monument were studied and followed. A substantial platinum tip was mounted on the top of the bronze cross surmounting the tower. From the base of this cross four heavy stranded copper



Machinery room under belfry containing elevator equipment and switch-boards for operation of the carillon solenoids

conductor cables were run down the corners of the building inside the walls. The lower ends of these cables were grounded to metal anchor plates set deep in the bed rock below the tower foundations. These cables were also bonded to the structural steel frame supporting the bells and to the steel framework of the elevator shaft.

The electrical operation of the bells is interesting. The clapper of each bell is connected by a steel cable to the armature of a weatherproof solenoid mounted on the steel framework which supports the bells. These solenoids operate on 230 volts and are connected by wires to a relay panel in the room just underneath the belfry, the main power supply being brought up to this room from the underground substation through conduit in the walls. The relays are operated by 24 volt circuits, each relay coil being connected by wires to the keyboard in the music room so that when any key is pressed by the musician, it makes contact and a relay is operated. This energizes the corresponding solenoid, giving a stroke on one of the bells. The bells are thus played by remote electric control from the keyboard.

In order that the musician in the sound insulated music room may hear the bells accurately and without the time lag due to their remoteness, a head set is provided. This connects electrically with a microphone in the belfry. The height of the tower and the arrangement of the eight arcades of the belfry chamber were designed to allow freedom for the sound of the chimes and to send out the full beauty of the music to the surrounding country. However, the chimes cannot be fully appreciated from the interior of the tower itself. An interesting experience is to stand in the belfry chamber underneath one of the large bells and to hear and feel the resonance of its tones long after the clapper has struck. One instinctively thinks of the poem beginning "Ring out, wild bells . . ."

Roll music also can be played automatically on the bells. This is accomplished by means of an automatic player machine wherein an electric motor operates a bellows compressor providing air to operate with the usual type of perforated paper music rolls. This automatic player is set in operation by electric contacts on a master electric clock. Any desired musical program can thus be played automatically without having a skilled musician at the keyboard. The hours are struck on one of the bells and Westminster chimes are played on five bells at each quarter-hour, all under the control of an elaborate electric clock mechanism.

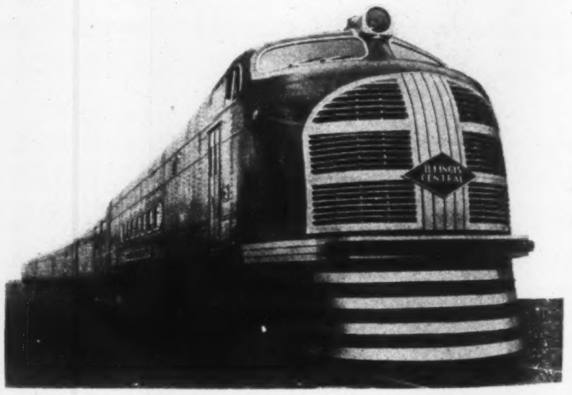
The four airplane beacon lights each have two 500 watt lamps. Normally, one lamp at each beacon burns during hours of darkness, but if any lamp burns out its companion automatically comes into service, thus assuring against possible failure of the signal. A relay device in the control closet on the entrance hall floor indicates when a lamp has burned out and its reserve is being used. The beacons are turned on and off in the evening and the morning automatically by an electrically operated clock with a compensating astronomical dial which varies the time daily in co-ordination with the sun.

Space does not permit a description of many other intricate and interesting details and refinements in the design and equipment of the tower. The real purpose of the tower has been fully accomplished, but its beauty must be seen and studied in its natural setting to appreciate fully the perfection of its conception and execution. As passing centuries add the dignity of antiquity, this tower will certainly come to be known as one of America's architectural gems.

Popularity of the new air conditioned streamline trains is well demonstrated by the Illinois Central's "Green Diamond," built for high speed operation between Chicago and St. Louis and put in operation last May. Since its inauguration it has carried capacity loads, and, in fact, the I. C. has had to operate over thirty overflow steam sections.

The "Green Diamond" is a five car articulated diesel-electric unit accomodating 120 passegers. The two chair cars and the diner-lounge car are air conditioned with dual heating and cooling units located in compartments, one on either side of one end of each car. Each contains a condensing unit comprising a 3 ton compressor driven by a 5 hp motor with a condenser fan on the opposite end of the motor shaft, and condenser, receiver tank and necessary piping. Air for the condenser is drawn in from the floor of the car, blown over the condenser and out through the side of the car. The upper section of the compartment contains the fans, filters, coils, etc.

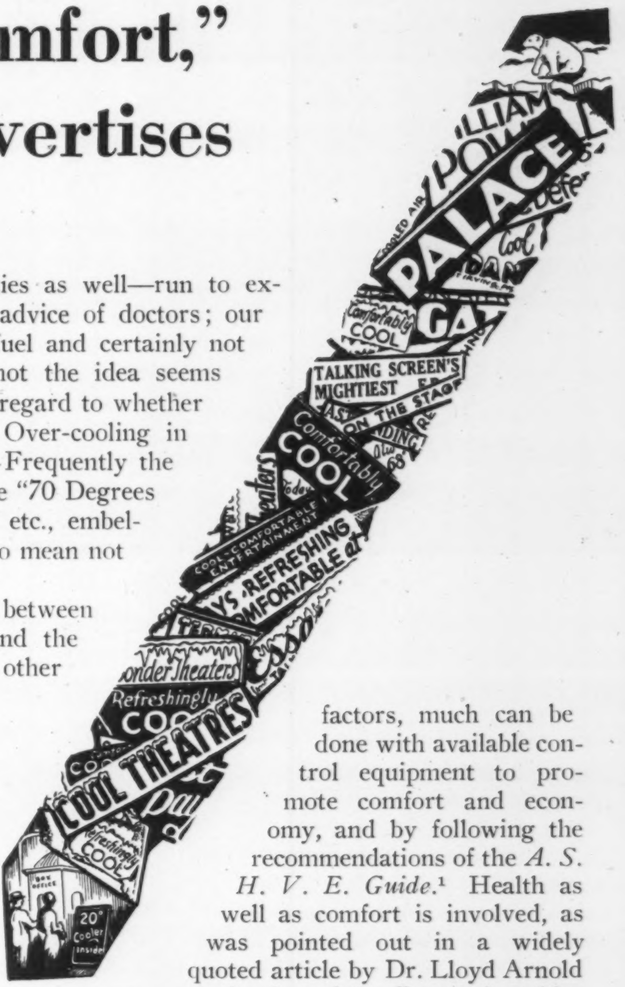
Air circulation is reversible, being supplied through overhead ducts and returned through floor ducts in summer, and in winter through floor ducts and returned through the overhead ducts. A boiler burning the same fuel oil as used in the main diesel engine supplies steam for train heating.



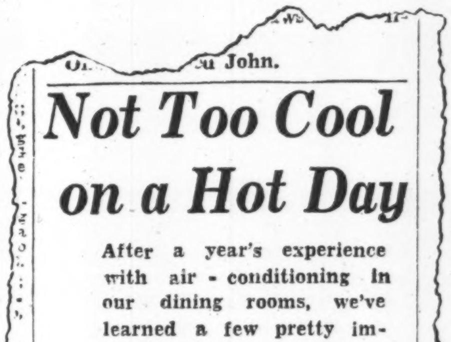
"Not Too Cool for Comfort," Hotel Metropole Advertises

AMERICANS, particularly—and no doubt other nationalities as well—run to excesses; our drinking water must be ice cold, against the advice of doctors; our living spaces are usually over-heated in winter, wasting fuel and certainly not conducive to health; with summer cooling, more often than not the idea seems to be to lower the temperature as much as possible without much regard to whether or no the result is the best from the comfort and health angle. Over-cooling in most cases probably is not the air conditioning engineer's fault. Frequently the blame rests on the owner, as witnessed by the signs that advertise "70 Degrees Cool Always," "Arctic Breezes," "20 Degrees Below Outside," etc., embellished with pictures of icicles and snow—phrases that are coming to mean not comfort but otherwise to a large part of the public.

While there is still much to be learned about the proper balance between inside and outside temperatures in summer air conditioning, and the problem is complicated by varying periods of occupancy and other factors, much can be done with available control equipment to promote comfort and economy, and by following the recommendations of the *A. S. H. V. E. Guide*.[1] Health as well as comfort is involved, as was pointed out in a widely quoted article by Dr. Lloyd Arnold on the harmful effects of sudden temperature changes, published in the October, 1935, HEATING, PIPING AND AIR CONDITIONING. Many other authorities could be cited.



Remembering the many signs advertising summer air conditioning and which to all appearances indicate that little or no thought is given to balancing inside conditions with outside, advertisements such as that of Cincinnati's Hotel Metropole (reproduced here) are worthy of note. According to Arthur C. Shafer, general manager of the Metropole, his system is designed to maintain inside temperatures from seven to twelve degrees below those outside. As proof of the fact that year 'round air conditioning benefits the hotel dining room he states that business this summer showed a fifty per cent increase in number of meals served and the check average held to the winter average. He also says that employees have enjoyed better health, and that even the flowers and plants in the air conditioned rooms have responded "notably."



u John.

Not Too Cool on a Hot Day

After a year's experience with air-conditioning in our dining rooms, we've learned a few pretty important things about it as it affects you and your health. For instance, we've learned that the temperature inside should be variable according to the heat outside, and the difference between outside and inside temperatures should not be too great for the easy adjustment of your body. We've learned, too, that the amount of moisture in the air (humidity to you) directly affects your physical comfort and that the scientifically correct figure is that which we use.

Now, all this care and attention for your well-being is pure selfishness on our part. Good health means good appetite. And good appetite, plus good food, has always meant good business for us.

hotel metropole

WALNUT, ABOVE SIXTH

Cincinnati's Hotel Metropole, realizing the importance of a balance between inside and outside conditions, advertises its dining room as "not too cool for comfort," in contrast to the all-too-usual frigid looking signs promising "always 70 degrees inside," "20 degrees cooler," etc.

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[1] Chapter 3, Ventilation and Air Conditioning Standards.

How Sheet Metal Ducts Are Fabricated

By **William Neubecker***

THERE are seven types of construction used for the fabrication of the longitudinal seams in square or rectangular duct work: (1) the grooved seam; (2) the riveted lap seam; (3) the double seam; (4) the Pittsburgh lock or hammered seam; (5) the standing seam; (6) the channel riveted seam; and (7) the cup joint. In making the cross seams, their constructive features are determined by the size of the ducts used.

Fig. 1 shows a duct fabricated with locked and grooved seams, which are fabricated only in large shops having power groovers. These ducts are constructed so that the outer surface is smooth, the grooved lock being on the inside. The locks are bent ⅜ in. wide, a finished lock or groove being indicated by *A*. The position of the grooves is determined as follows: Assuming a duct to be 27 × 42.5 in. the girth is 27 + 42.5 × 2 = 139 in., plus 3 × 0.375 × 4 equals 4.5 in., a total of 143.5 in. The regulation lock of ⅜ or 0.375 in. is assumed; each lock has 3 × 0.375 or 1⅛ in. and as there are four finished grooves, 4 × 1.125 = 4.5 in. As the sheets come in 20, 24, 26, 28, 30 and 36 in. widths, then four 36 in. wide sheets would be required, with a waste of only ½ in. It is important that calculations of this kind be made to avoid unnecessary waste.

Fig. 2 shows a duct having riveted seams. This construction is used only on heavy material on which no locks can be made. The corner laps are usually made ¾ in. and the level laps 1 in., as shown respectively by the detailed sections *B* and *C*.

Fig. 3 shows a duct with double seam corners; this is used only when each side of the duct takes up the full width of the metal sheet. *D* shows the finished lock which may be made by two methods. The first is to make a single corner lock as shown at *E*, which is then turned down as shown at *D*. The second method is to turn the locks as in diagram *F*, then slide one into the other as at *G* and close tight.

Fig. 4 shows the duct constructed with a "Pittsburgh"

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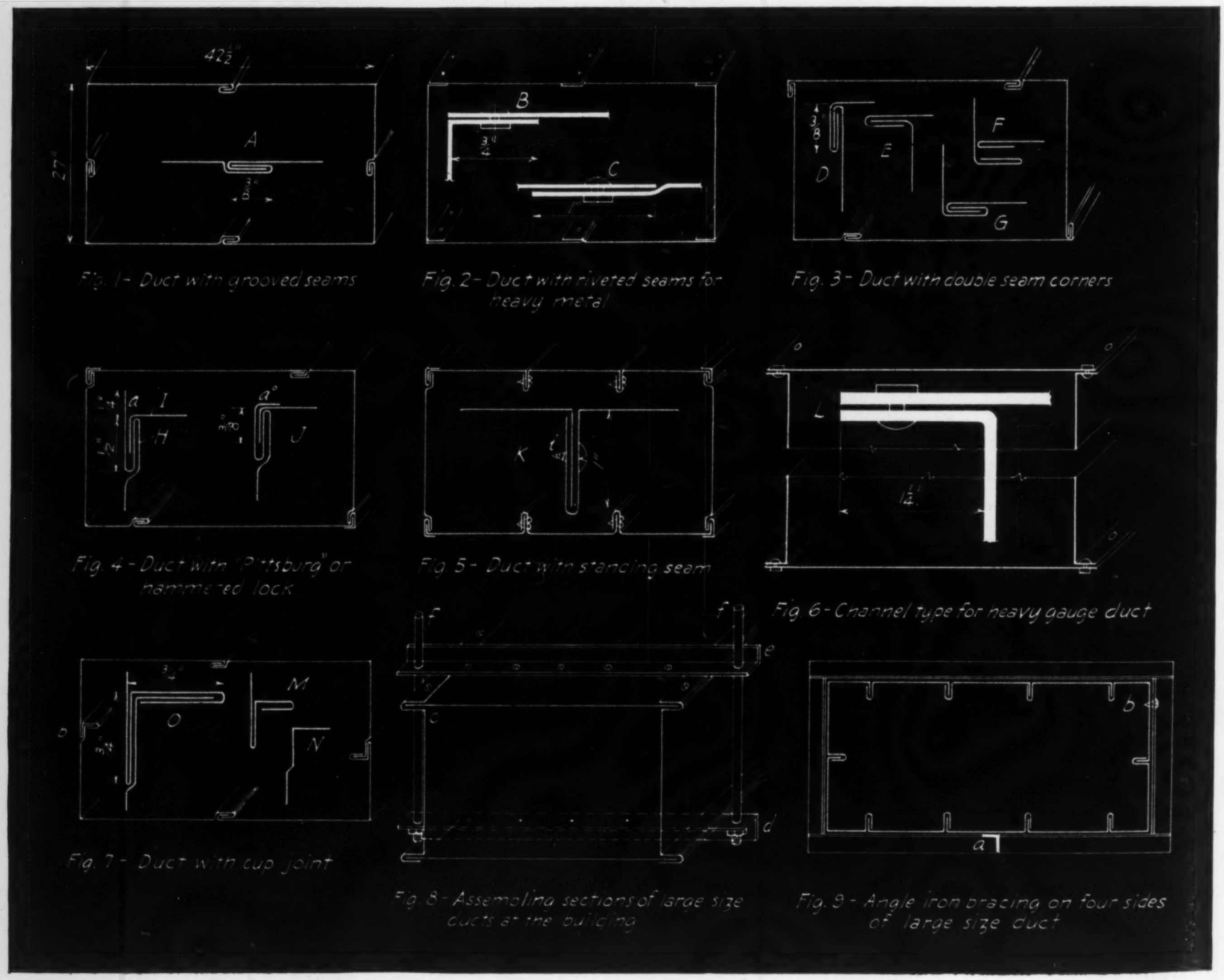

Fig. 1 - Duct with grooved seams

Fig. 2 - Duct with riveted seams for heavy metal

Fig. 3 - Duct with double seam corners

Fig. 4 - Duct with "Pittsburg" or hammered lock

Fig. 5 - Duct with standing seam

Fig. 6 - Channel type for heavy gauge duct

Fig. 7 - Duct with cup joint

Fig. 8 - Assembling sections of large size ducts at the building

Fig. 9 - Angle iron bracing on four sides of large size duct

Methods of fabricating sheet metal duct work

Feeling that air conditioning and ventilation design engineers are not too familiar with the details of duct fabrication, the author has briefly described the types of seams or joints which are commonly employed in this work, with which he has been identified for many years

or hammered lock. These locks are employed in the construction of duct corners, elbows, transitions, reducers, etc. One side of the duct is formed as indicated by *H*, with ¼ in. flange projecting above as at *a*. The connecting side has a ⅜ in. flange turned at right angles as in diagram *I*, which sets into the groove at *a*, after which the ¼ in. flange is turned down as shown by *a°* in *I*.

When the ducts are of such size that a succession of sheets is required to make up the duct, the standing seam lock is used as shown in Fig. 5, so as to give rigidity to the large size dimensions. This construction is generally used for ducts made of No. 20 to 14 ga metal. Standing seams are placed on the inside, tightly closed and secured with sheet metal screws about 10 in. apart. *K* shows the seam secured with sheet metal screw *i*.

Fig. 6 shows the method of fabricating ducts of heavy metal (No. 13 to 10 ga) using a riveted corner seam of the channel type. These joints can also be welded. If riveted the rivets should be spaced 2½ in. on centers, and the seam should be lapped not less than 1¼ in. as shown in *L*.

Fig. 7 shows a duct made up with a cup joint. This construction is used when vertical flues are to be placed inside enclosed shafts, the shaft to be lined in sections, the joints made by using longitudinal cup joints, as shown by diagram *O*, slipping in one over the other from the top down. Note the construction as shown by *M* and *N*. The flange in *N* slides into the groove in *M* completing the finished joint at *O*.

When large ducts are fabricated on the job, they are locked and riveted as shown in Fig. 8; the top and one side are erected first and then the bottom and the opposite side. The sides are fabricated the full length of the sheet, and the top and bottom in 36 in. lengths or the width of the sheet. The cross seams are made standing seams as shown in Fig. 5. The angle supports *d* and *c* in Fig. 8 are placed 3 ft apart and secured to the sheet metal with metal screws as shown. The corner joint *c* is also metal screwed. In fabricating this type of duct the hangers *ff* are set first and the duct built inside of them.

All of the methods described in Figs. 1-8 are fireproof, no solder being used.

Fig. 9 shows how large ducts are rigidly supported by using angle iron bracings on all four sides of the duct. Placing standing seams on the inside of the duct gives a smooth outer surface to which the angle *a* is secured with metal screws as indicated by *b*. These angle iron frames are usually placed about 3 ft apart.

Air Conditioning for Health

THE effect of air conditioning on health and its uses in the treatment of diseases are considered by many to be the most important contribution of air conditioning to the future. While this aspect of the subject has not received the attention that industrial and commercial applications have been given, there is a growing appreciation of what the future of air conditioning may be in promoting health and happiness. Certainly, a great opportunity for serving humanity is offered.

In order to focus attention on what is now known of the medical and health aspects of air conditioning, and to stimulate thought on the future of such applications, contributions from authorities on the subject will appear regularly under this heading.

Air Conditioning, in Replacing Ventilation, Introduces a Newer Viewpoint

By C.-E. A. Winslow*

ONE of the most significant advances of the past 15 years has been the replacement of the conception of "ventilation" by that of "air conditioning." Ventilation is "the process of supplying or removing air by natural or mechanical means to or from any space." But air conditioning "in its broadest sense implies control of any or all of the physical or chemical qualities of air." Thus a crude quantitative conception has been transformed into a refined qualitative ideal, and an ideal which must be formulated on physiological rather than on purely mechanical grounds.

An excellent example of the newer viewpoint is offered by Yaglou's important studies at Harvard on the relation of air changes to the removal of body odors, studies which have indicated that standards must be widely varied under different operating conditions. The importance of such investigations is emphasized by recent evidence from studies in the John B. Pierce Laboratory in regard to the very definite effects of rather slight odors upon appetite.

Evidence continues to accumulate as to the important influences of air temperature upon human health, comfort and efficiency. From the standpoint of humidity we know that very dry or very moist air is undesirable, although the *A. S. H. V. E.* studies at Pittsburgh suggested that, over a rather wide median range, variations in relative humidity are not of major importance. The most fascinating possibilities at the present moment are opened up by an analysis of the relative physiological effects of radiant and convected heat upon the human body.

In the past we have, perhaps, tended to limit our consideration of ventilation problems to a consideration of positively harmful influences. The objective of hygiene, however, is not merely to prevent people from being killed, but to make human life full and efficient and satisfying.

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*Professor of Public Health, Yale School of Medicine; Director John B. Pierce Laboratory of Hygiene, New Haven, Conn.

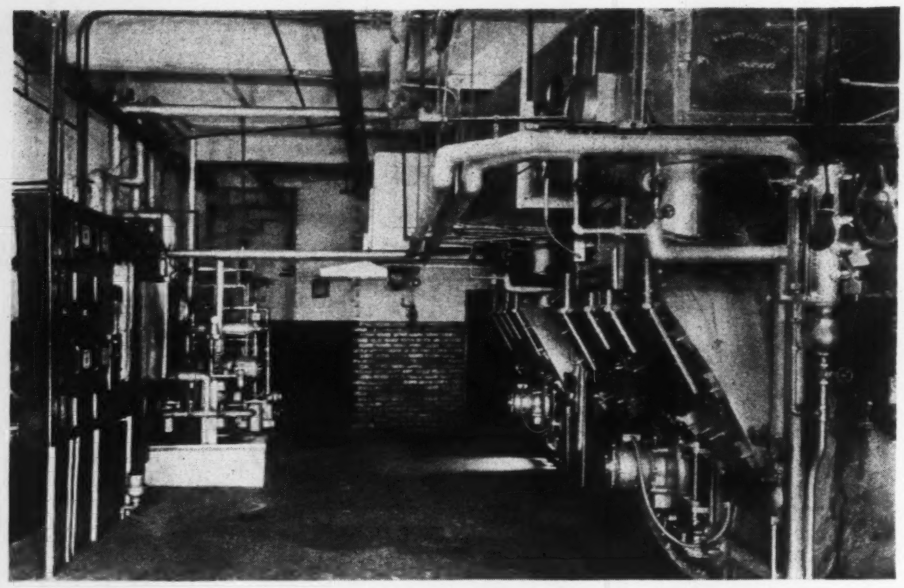

Fig. 1—Industrial boiler installation with electrical combustion control

Combustion Control for Oil Fired Boiler Plants

By **Kalman Steiner*** *and* **Paul R. Unger****

The many variables which require regulation and the several methods of control which have been devised make the subject a complex one; control installations range from simple, manually operated types to elaborate, fully automatic systems. . . . Following their discussion of the primary object of a combustion control system, the authors describe the five major factors involved and the corresponding methods of regulating them . . . . The information given is of equal interest to operators of plants which are not oil fired, as the subject is fundamental

THE subject of control for the oil-fired industrial boiler plant is necessarily complex, for there are many variable factors which require regulation, and many methods have been devised for accomplishing control over one or more of these variables. Hence it is found that in actual practice installations will be equipped in a manner ranging from strictly manual—with no instruments or control apparatus beyond simple hand operated valves—to extremely elaborate systems designed to automatically compensate for all possible variable factors and to indicate and make records of operating performance.

Primary Object of a Combustion Control System

Essentially, the primary object of any combustion control system is to maintain constant steam pressure, or to limit pressure variation as closely as possible, with minimum fuel consumption. An elementary control system would be one that merely proportioned oil feed to boiler pressure. This could be done inexpensively in at least three ways, a direct-acting oil valve actuated by steam pressure through a bellows or diaphragm, or a reversing motor controller actuated by a pressurestat and in turn transmitting motion to an oil valve stem or to an oil pressure regulator, or two metering valves in conjunction with a solenoid valve whereby the flow through the metering valve set for high fire could be opened and shut through a pressurestat while the metering valve set for low fire would flow continuously.

Such an elementary system is simple and will maintain desired steam pressure. But almost without exception the resultant combustion would be inefficient, for this method gives no control whatever over air supply, and as was pointed out by the authors in the July HEATING, PIPING AND AIR CONDITIONING, air must be correctly proportioned to the fuel if loss from excess air, and smoke and carbon formation, are to be avoided. It follows that a control system must synchronize air admittance in amount required by the oil. Practically, this is far from simple, for numerous reasons, some of them inherent to the combustion of any fuel, others peculiar to the burning of oil.

The problems to be solved for correct, efficient, and effective control of oil combustion are these:

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*Ace Engineering Co., Chicago, Ill.

**Mid-West Heat Service Co., Chicago, Ill.

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1. Selection of a suitable device for proportioning oil flow to boiler load in a manner which will maintain required steam pressure, within permissible limits.
2. Controlling of stack draft to compensate for variations due to atmospheric conditions, such as wind direction and velocity and barometric pressure.
3. Synchronizing of both primary and secondary air to oil flow.
4. Maintenance of uniform oil pressure and compensation for variation in oil viscosity.
5. Compensation for changes in pressure drop through the boiler with changes in load conditions.

Even when all five of these factors are under adequate control, it is also necessary that air infiltration because of leaks in the boiler setting be prevented.

The Five Major Factors in Combustion Control

Each of these five major points in combustion control can now be considered in detail.

1. *Combustion Controllers*—There are available a large number of very satisfactory combustion controllers that are adaptable to fuel oil. These may be classified as electrically operated; fluid operated, using either air, oil, or water, under pressure; combination electric and fluid operated.

The simplest form of electric modulation consists of a pressurestat having a small resistance coil similar to a Wheatstone bridge, connected to a reversing motor in such manner that variations in pressure are translated into electric impulses which will move the motor in the direction required to offset the pressure change. Rotation of the motor is communicated to an oil valve, and to air admission ports on the boiler front or to an uptake damper, or to both. Fig. 1 illustrates an installation of this type.

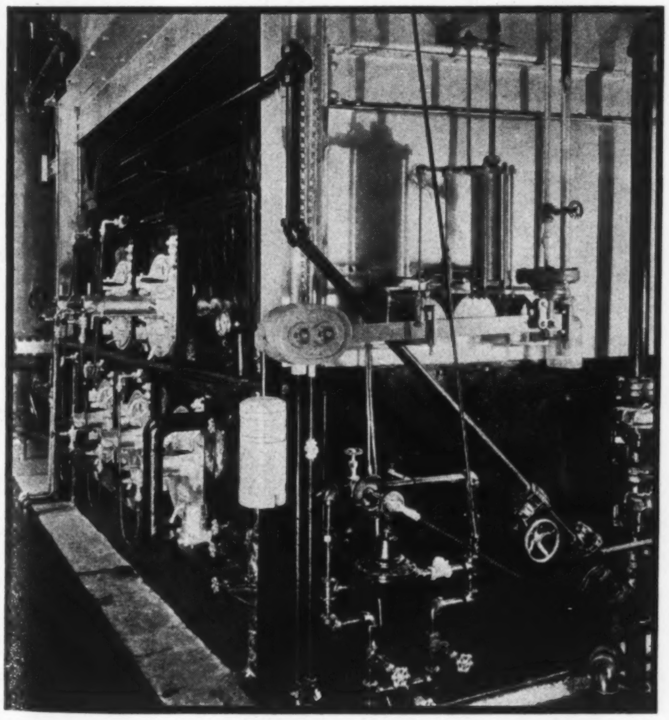


Fig. 2—This combination oil and gas fired job at a brewery is controlled by a hydraulic type system

Fluid controllers are made in a variety of forms, using compressed air or oil under pressure or water under pressure. Boiler steam pressure is caused to operate a pilot valve, through a diaphragm or bellows or similar device, so that fluid is admitted into a cylinder fitted with a piston. The admission is directed to that side of the piston which will cause it to move in the required direction for offsetting the pressure change which caused the pilot valve motion. The piston is linked to the fuel oil control valves, to the air inlets at the burner, and to the uptake damper, the latter in combination with or in lieu of the former. By running a line shaft it is possible to have a single controller regulate a battery of boilers. This is not advisable if peak efficiency is sought, for each boiler may require its own individual draft setting to allow for slight differences in pressure drops through boilers, proximity to the stack, etc.

If sufficient water pressure (over 30 lb) is available at all times and if the water is reasonably clear, this medium will do and it is the least expensive. If air pressure is available, it is more feasible and gives more accurate control. In larger plants, however, oil seems to yield the best all-round results; the usual method of application is to circulate it, under pressure, between a small reservoir and the control system. A light petroleum oil is used. Fig. 2 shows such an installation.

Both the electric and pneumatic or hydraulic can be combined to secure certain special results as regards oil valve opening and air supply.

2. *Draft Controllers*—Commercial forms of draft control apparatus may be classified as the balanced barometric type; and the overfire control type, subclassified as the pneumatic, hydraulic, and electric types.

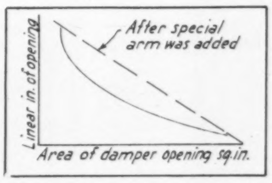


Fig. 3 — Relation between inches of damper rod movement and area of opening

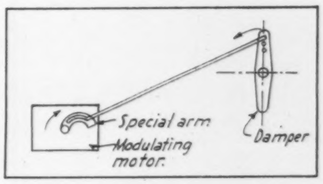


Fig. 4 — Special cam for regulating damper opening

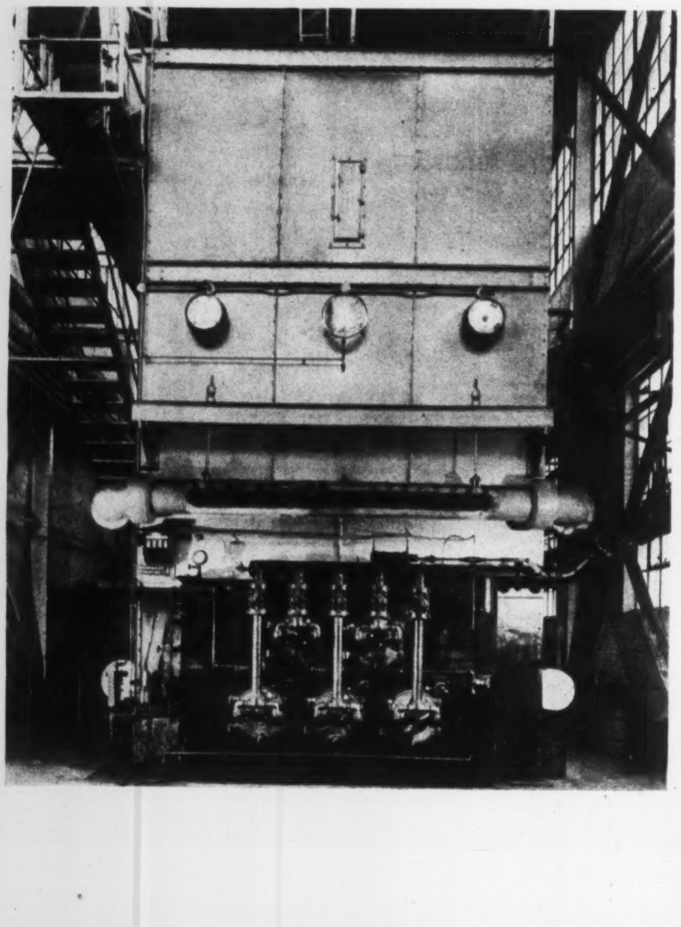
The balanced barometric draft controller is installed either on the breeching or at the base of the stack. If on the breeching, it must be located between the stack and the first boiler on the line. It consists essentially of a damper plate mounted on knife edges in a position parallel to the breeching or direction of flow of the gases, and it swings into a box-like frame which is attached to the breeching over an opening in it which corresponds to the size of the frame. The damper plate is counterbalanced by an adjustable weight, whereby it can be caused to swing inwards and thus allow air to be drawn directly into the breeching from the boiler room. Thus at any predetermined intensity of draft in the stack or breeching the damper will check the draft by swinging inwards and so prevent the equivalent amount of air from being drawn through the firebox. While the balanced barometric controller is relatively inexpensive and offers low-cost operation from a maintenance viewpoint, it has two objections. First, it removes large quantities of warm air from the boiler room, and so increases the radiation losses from the boiler and steam pipes. Second, it cannot and does not compensate for changes in draft requirements arising from sooted boiler tubes, from air leaks occurring in boiler settings, and from varying draft requirements resulting from varying load conditions, as regards a single boiler installation, and in the case of a battery it makes no provision for individual boiler draft needs as regards pressure drops through separate boilers.

In the overfire draft controller, a tube is inserted into the furnace through the boiler setting so as to communicate furnace pressure to a diaphragm which in turn can actuate either a piston (on pneumatic or hydraulic types) or a resistance coil of a motor. Whatever be the means, the resultant motion is employed continuously to vary the position of the uptake damper so that a uniform draft may be maintained within the boiler firebox.

3. *Synchronizing Air to Oil Flow*—Care must be taken in linking the oil valve and damper control to compensate for the fact that the area of the path of air flow, rather than the linear movement of the damper rod, is proportioned to the effective opening in the oil valve. The curve showing the relation between inches of damper rod movement against area of opening resulting is usually not a straight line function, but rather a curved-line function, as in Fig. 3. For successful control it is necessary to have straight line operation. For accomplishing this there are various compensating cam arrangements available. However, it is usually necessary to design a cam for each separate installation.

The authors recall a plant in which, due to this curved-line variation, a CO_2 ranging from 9 to 14 per cent would be recorded with everything about the system apparently in order. Once the nature of the difficulty was determined, a special cam was designed and made into an arm of the controller to regulate the damper opening (Fig. 4). Essentially, it functioned to increase the damper speed when starting to open.

Fig. 5—This combination oil and gas fired job is equipped with the metering type of combustion control



4. *Regulation of Oil Pressure and Compensation for Oil Viscosity*—It might be said that rigid control over oil pressure and compensation for changes in oil viscosity offer the most troublesome features in oil combustion systems, or in general that regulation of oil flow presents knotty technical problems. Conventional valves will maintain uniform flow only if two factors, oil pressure and oil viscosity, are held within close limits. For obviously, for any position of the oil valve corresponding to a set of conditions in the controller, the amount of oil passed through a momentarily fixed orifice in the valve is determined by pressure and viscosity; with a fixed orifice the amount of oil will vary directly with the pressure and inversely with the viscosity. At the same time, of course, changes in pressure or viscosity would produce no accompanying variation in the air damper settings. Hence it is imperative to exercise as close control as possible over oil pressure and viscosity.

The customary method of pressure regulation is through an oil pressure relief valve placed at the pump discharge, in the case of electric driven oil pumps, and a steam governor for steam driven pumps. Uniform viscosity can best be maintained by holding the oil temperature constant, as the viscosity of oil is a function of its temperature. Viscosity compensating devices are now available only for single burner installations; as yet nothing has been developed which will automatically compensate for viscosity changes in multiple burner operation, unless a separate pump be used for each burner.

The plant operator can assist in the securing of uniform oil feed by trying to use oil of fairly uniform specifications and characteristics. When successive deliveries of fuel vary in physical attributes, it may be found that duplicate oil temperatures will not produce duplicate oil viscosity. It then becomes necessary for the operator to study his CO_2 records in order that adjustment may be made in the control apparatus to overcome this factor.

5. *Compensation for Changes in Pressure Drop Through Boiler*—So far, the apparatus discussed has been designed primarily to maintain predetermined rates of flow and draft intensities. So long as ideal conditions exist, such as clean boiler tubes and fairly uniform load, or at least fairly uniform pressure drop through the boiler at various ratings, the plant's efficiency can be held satisfactorily high.

But in many cases there exists another factor which cannot be predetermined, for it depends entirely upon instantaneous conditions; this of course is the amount by which the draft is affected by the additional friction caused by soot on the tubes and by the increased velocity of gases through the boiler at high ratings. To meet this situation there has been developed the metering type of combustion controller. This equipment compensates for changes in draft loss through the boiler and constantly corrects the air and oil admitted and the gases discharged to the breeching by maintaining at all times a definite ratio between the draft loss in the boiler and the pressure drop across an orifice plate in the oil feed line. This control also compensates the linkage directly from the CO_2 analysis. Thus all the inherent variables can be controlled from one master controller, thereby assuring constant steam pressure and continuous high combustion efficiency.

Briefly, a metering type controller consists of a pressure sensitive element connected to the main steam header. From this device impulses are transmitted to air and oil flow controllers. The air flow controller is also connected to both the inlet to the first pass and exit from the last pass, so that the differential pressure between these points will modify the action of the damper controller in swinging the uptake damper. The oil flow controller, meanwhile, is also connected to both sides of the orifice in the oil feed pipe, so that the oil valve opening will be influenced both by the master controller which is responding to changes in steam pressure and by the rate of oil flow as reflected by the orifice plate. In this manner the oil pressure can be varied to correspond to boiler requirements. An additional reversible motor operates from the CO_2 recorder, compensating the linkage for excess air as indicated by each successive gas analysis. For a battery of boilers, only one master controller is necessary, but each boiler must be equipped with individual oil and air flow controllers.

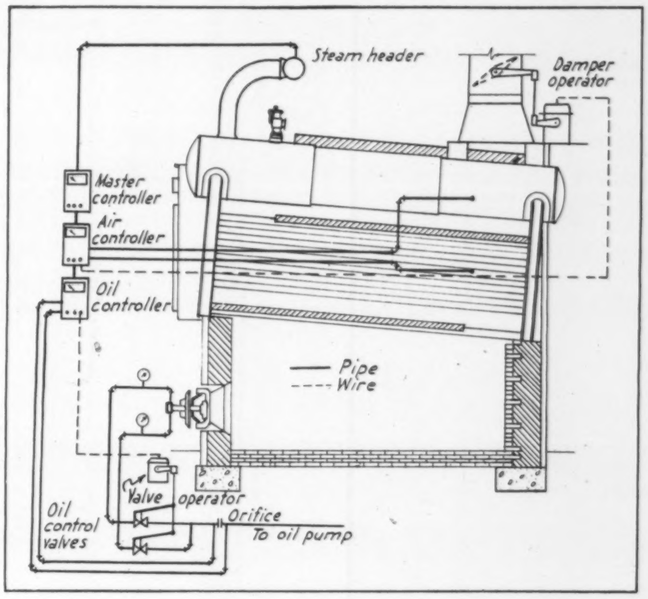


Fig. 6—Typical metering type combustion control system

The control systems as outlined up to and including Point 4, when properly installed, should give long and effective service, and are particularly adapted to moderate sized plants ranging from 100 to 400 hp. Under such conditions the equipment cost represented in the control system will be amply justified by the resultant fuel economy. The metering control system, outlined in Point 5, is much more elaborate and expensive, and necessarily is restricted to use in very large industrial plants. But when size of the plant justifies its use, it will soon warrant the investment cost by the resultant high economy of operation.

Power Plant Piping

Increased pressures and particularly increased temperatures have given added importance to the selection and construction of proper piping materials. Creep must be considered, for all metals elongate to some extent at elevated temperatures. The problem has been to find what metals having suitable strength and ductility have creep rates within certain desirable limits.

Authorities, however, are not in full agreement with regard to desired rates of creep, for elongation is much greater during the early stages of use than later on. A tentative rate of 1 per cent in 100,000 hr is used by some designers. Metals must also resist external and internal corrosion, which may be quite rapid if oxygen is present at high temperatures.

Alloy steels, containing chrome, nickel, molybdenum, and other metals in various proportions, are in use for pipes, valves, and bolts. Stellite facings, as well as other alloys, are employed on seats and disks of valves. Practically all joints are now welded, and even valve bodies are being welded to the piping. Valves can be removed from the pipe lines by cutting free with a torch. Piping materials and welding practice were discussed at length in a recent paper prepared by Dawson.[1] Piping experiences with steam at 1000 F at the Delray station of The Detroit Edison Co. were discussed in a recent paper,[2] while corrugated and creased-bend piping for expansion purposes has been carefully studied in a recent research.[3]

From "Development and Performance of American Power Plants," by A. G. Christie, The Johns Hopkins University, Baltimore, Md., contributed by the power division for presentation at a meeting, Niagara Falls, N. Y., Sept. 17-19, of the *American Society of Mechanical Engineers.* Complete paper published in *Mechanical Engineering,* September, 1936.

[1] "Alloy Steels for Welded Steel Piping," by J. R. Dawson, Midwest Power Conference, Chicago April, 1936. (Abstracted in HEATING, PIPING AND AIR CONDITIONING, August 1936, pp. 435-437.—ED.)

[2] "High Temperature Steam Experience," by P. W. Thompson and R. M. Van Duzer, *Trans. A.S.M.E.,* Vol. 56, 1934.

[3] "The Strength and Flexibility of Corrugated and Creased Bend Piping," by R. L. Dennison, *Jour. A.S.N.E.,* August, 1935; *Engineer* (London), Sept. 20, 27, Oct. 4, 11, 18 and 25, 1935.

What Is Air Conditioning?

Air conditioning in this latitude should provide for *a year round service,* and hence we must be prepared to deal with both winter and summer conditions. Briefly stated, (1) a complete system of air conditioning (for human comfort) for *winter service* should provide for the *controlled* production of *heat* and *humidity,* with the *removal* of a large part (75 per cent or more) of *dust* and *dirt* floating in the air; and (2) a complete system of air conditioning for *summer service* should provide for the control or regulation of air temperature or of humidity or of both within certain rather wide limits by either *air cooling devices* of various types or by *dehumidifiers* or by both. By reducing the humidity, that is, *condensing* or *absorbing* the *moisture* in the air, the amount of actual air cooling may be greatly reduced. In any case, air cooling should be moderate in amount.—A. C. WILLARD, President, University of Illinois, at first annual conference on air conditioning.

Method of Designing a Heat Exchanger

T. J. Kauders* explains the method of designing a pit type heat exchanger or reclaimer, using a problem submitted by a reader of H. P. & A. C. as a typical example. . . This type of equipment has applications in many plants in reclaiming heat from waste liquids to reduce fuel costs and boiler load, as well as the use outlined here

THE problem presented is a fairly common one of industrial heat exchange, particularly in textile plants, dye houses and laundries. In the laundry industry, for example, a large amount of water is discharged from the washroom, which formerly was wasted directly to the sewer. However, in recent years heat exchangers (commonly known as heat reclaimers) have been developed to transfer the heat in the waste water to the fresh water supply.

A typical example is a plant that installed a reclaimer, or exchanger, capable of transferring 10,000,00 Btu per hr from 30,000 gph of waste water entering the reclaimer pit at a temperature of 120 F and lowering the temperature to 80 F, at the same time preheating 20,000 gph of fresh water from an initial temperature of 50 F to a final temperature of 110 F, thus greatly reducing the fuel bills for water heating and the boiler load.

The problem presented here is similar. In this case it is desired to reduce the temperature of 800 gpm of water from an initial temperature of 100 F to a final temperature of 80 F when furnished with 600 gpm of cooling water at an incoming temperature of 55 F.

There are manufacturers who specialize in the building of exchangers or reclaimers especially adapted to this type of problem. A pit type reclaimer, Fig. 1, consisting of a nest of U shaped copper tubing expanded into a tube sheet, properly designed, will efficiently effect the required heat exchange.

Note that the water to be cooled flows into the pit or sump and surrounds the coils, while the cooling water, or water to be heated, flows through the tubes. The water chambers, or heads, have internal ribs or baffles which create a large number of passes. Note also that the cooling water, or water to be heated, is introduced into the inlet at the bottom of the water chamber and flows through the lower bank of tubes, back into the front head, thus making two complete passes in the lowest strata of water. Upon entering the front head, the water is raised vertically in the head and flows through the next series of passes, at a higher level than previously, thereby absorbing heat from the cooler water first. This process is repeated until the water leaves the reclaimer at the highest point, after having flowed through the top layer of tubes, where it is heated by the hottest water in the sump.

Note, also, that the water to be cooled flows into the pit or sump at the water level and overflows at the opposite end of the pit at the same level, thus establishing the water level in the pit. The dam wall, or vertical baffle, extending down to within 6 in. of the bottom of the pit forces all of the water leaving the pit to flow underneath the dam.

Naturally, the hottest water, being the lightest, will lie on the top and the coldest water on the bottom. Therefore, only the bottom strata, or coldest water, is discharged from the pit.

It is apparent that due to the baffle or dam wall in the pit and to the directional ribs in the water chamber of the reclaimer itself, an excellent counter-flow is created whereby the coldest raw water is being heated by the coldest treated water, and as the raw water is warmed it is automatically heated to a higher degree by correspondingly hotter treated water.

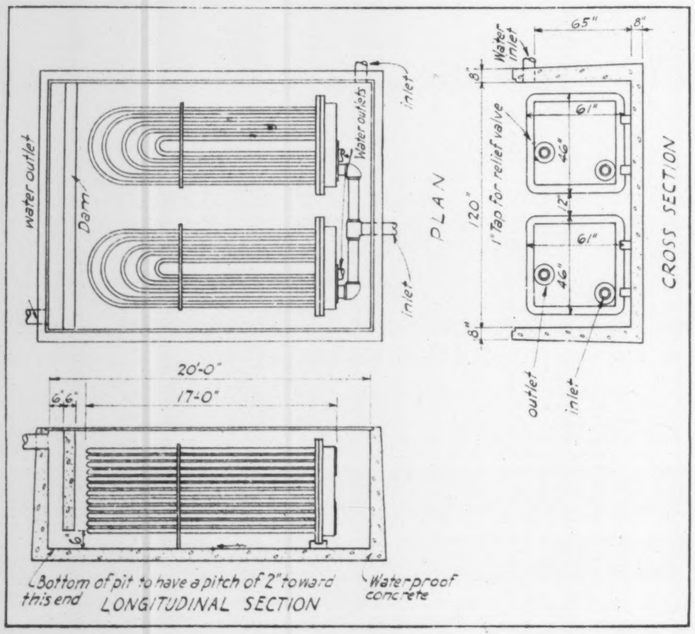


Fig. 1—Pit type heat reclaimer or exchanger made up in two units for installation in sump

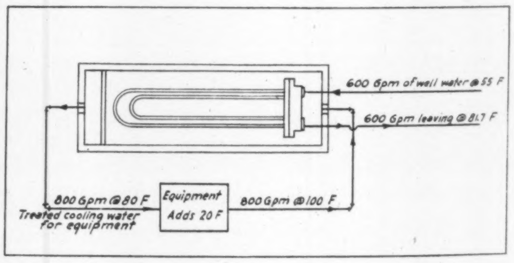


Fig. 2—Conditions of the problem

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*The Patterson-Kelley Co., Inc., Chicago, Ill.

Calculations for Amount of Heat Exchange Surface

For this type of exchanger, the writer would recommend seamless drawn copper U tubes 1¼ in. outside diameter as most practical to meet the various conditions of pressure drop, size of head, general ruggedness, and resistance to corrosion. Calculations for determining the amount of heat exchange surface follow:

Problem: To cool 800 gpm from 100 F to 80 F with 600 gpm cooling water at 55 F (Fig. 2).

Hourly Btu input = 800 × 60 × 8⅓ × 20 = 8,000,000 Btu. This will raise the temperature of the cooling water

$$\frac{8,000,000}{600 \times 60 \times 8\frac{1}{3}} = 26.7 \text{ F rise}$$

Therefore, initial temperature of cooling water = 55.0 F
Temperature rise of cooling water = 26.7 F

Final temperature of cooling water = 81.7 F

The general formula for figuring heat exchange surface is:

$$S = \frac{H}{d \times K}$$

where S is the heating surface in sq ft, d = logarithmic mean temperature difference, K = coefficient of heat transfer in Btu/hr/sq ft/F difference, H = total heat input in Btu per hr.

In this problem H = 8,000,000 Btu.

$$d = \frac{(tc - tf_1) - (tc_1 - tc)}{\log_e \dfrac{tc - tf_1}{tc_1 - ts}}$$

where tc = initial temperature of water to be cooled, tc_1 = final temperature of water to be cooled, tf = initial temperature of cooling water, tf_1 = final temperature of cooling water.

Substituting in the above formula, we find that d = 21.4 F.

$$S = \frac{8,000,000}{1926} = 4154 \text{ sq ft}$$

As this surface is made up of 1¼ in. O. D. tubes of which there are 3.06 lineal ft per sq ft of external surface, this would require 3.06 × 4154 = 12,712 lineal ft of this tubing.

As a unit of this size and capacity would be difficult to handle, an exchanger, or reclaimer, of this capacity is usually made up in two units, placed in the same pit. Two units, each of approximately half this capacity of the dimensions as shown on Fig. 1 could be accommodated in the 12 ft by 20 ft by 10 ft deep sump. In such a two unit exchanger the well water can be introduced into the units in parallel, as shown in the sketch, so that each unit performs one-half of the heat exchange.

Another type of exchanger which could be used is the closed type which is the conventional closed type shell and tube, liquid to liquid, exchanger. There are, however, certain disadvantages which would mitigate against this type for the particular service in mind.

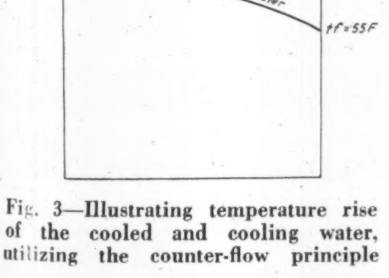

Fig. 3—Illustrating temperature rise of the cooled and cooling water, utilizing the counter-flow principle

The open, or pit type, offers a large volume of storage for the 800 gpm of treated water. Therefore, should there be fluctuations in the delivery of this water, or should there be intervals when no flow would exist for a given time, there would still be ample water in the sump from which the cooling water could absorb heat.

The Problem

Raw 55 F water from a well is being pumped at a rate of 800 gpm through air compressors, transformers and motors for cooling. After this raw water passes through these units the water is discharged into an open sump 20 x 12 ft and 10 ft deep. Another pump removes this water from the sump for use in manufacturing processes, at a rate of 600 gpm. Temperature of warm water in sump has no bearing on process. By this method 200 gpm are wasted.

The raw water from this well is not the best to circulate through the equipment for cooling; therefore conditioned water is being considered. To avoid undue expense involved in conditioning 800 gpm the idea of placing a heat exchanger in the sump presents itself.

Thus, the raw water from the well will be pumped to the heat exchanger and the discharge will be used in the manufacturing processes. The 800 gpm used for cooling the air compressors, etc., will circulate from the sump through the motors, compressors and transformers and back to the sump, entering at approximately 100 F. As it leaves the sump the temperature should be 80 F.

What size tubes, how many tubes and what is the length of tubes required to cool the 800 gpm from 100 F to 80 F using 600 gpm of 55 F cooling water?

Contrarily, in the closed type, there is no storage capacity and should the same conditions exist as outlined above, the cooling water would have no source of heat from which to absorb heat. In order to avoid this it would be necessary to install elaborate apparatus to synchronize the flow of raw and treated water.

Comfort Cooled Bus Serves as Display Room

A stream-lined, air conditioned bus serves the Duro Metal Products Co. as a "show shop for home mechanics" in merchandising their line of tools and machinery for home workshops. Cooling was deemed necessary in order that the bus might be kept closed against dirt which would ruin the merchandise display, to exclude traffic noise in order to permit business conversations, and to maintain comfortable conditions when the bus is standing in the sunshine.

The compressor has a capacity of one-half ton, and is supplied with 32 volt power from a storage battery and generator set. Inside temperature is automatically controlled to maintain a differential of about 15 F. Walls and ceiling of the bus are insulated, and the windows are double, set in rubber and permanently closed.—ALLEN TRASK.*

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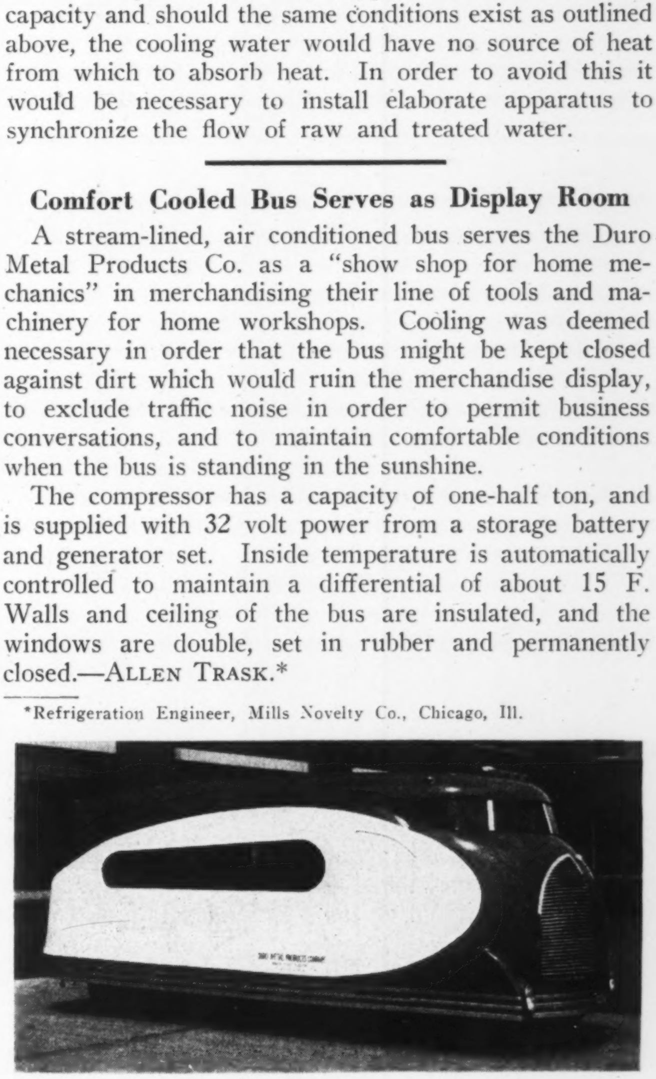
*Refrigeration Engineer, Mills Novelty Co., Chicago, Ill.



Get Ready Now for Winter Operation of Conditioning System

By **Rush D. Touton***

The changing seasons of the year introduce new problems in the operation and maintenance of air conditioning systems, for the flow of heat and moisture into the building in summer is reversed in winter. For best operation, a survey and check-up before each season is advisable, and Mr. Touton suggests what should be done now to prepare for air conditioning service during the coming months. . . . Fall also offers the opportunity to make major repairs and overhaul and test much major equipment.

AIR conditioning involves but few static problems—the flow of heat and moisture into an enclosure during summer is, in practically every case, reversed in the winter, and therefore new operation and maintenance problems arise. Air conditioning must compensate for the persistent ebb and flow of heat and moisture out of and into a building. Neither the rate nor the direction of this Btu and moisture travel is constant; therefore the method of operation must change in accordance with seasonal demands.

Also, the temperatures and dew points most suitable for warm weather operation are generally not to be preferred in winter. Many raw materials and products respond quite differently to treatment in changed climatic conditions and many require an alteration in manufacturing processing in anticipation of the atmosphere to which they will subsequently be exposed. For example, cigars should reach the market with a higher moisture content in the cold, dry months in order to preserve the best sales quality. Furthermore, it is commonly recognized that the desirable summer dry bulb temperature range of 77 to 80 F should be reduced to 70 to 72 F in winter to maintain a well-balanced physiological sensation throughout the year. Particularly in comfort work, distinct economic savings will result from utilization of this principle.

It is of assistance in operating an air conditioning plant if the annual program of operation is divided into seasonal intervals. During these periods certain fairly well sustained trends may be expected, and the routine will be most effective if designed to follow these general swings in outside weather. With design data, weather records and forecasts at hand, the development of a system of load factors is recommended. Careful observation should be made of the heat and moisture retaining capacity of the enclosure and its contents. This factor, particularly in a well insulated structure or one with a high thermal capacity, will assist materially in stabilizing inside conditions during short variations in outside weather. Similarly, the operator must take the constant heat output of motors, lights and processes into account.

For instance, a system capable of maintaining 70 F and 65 per cent relative humidity in 0 F weather will obviously require its maximum Btu output under those conditions only. For all intermediate conditions,—corresponding in general to the season and more specifically to the outside temperature, humidity and wind conditions observed at the beginning of the operating period—a working percentage of capacity range can be established. These percentages can be put to effective daily use in determining damper positions and valve and thermostat settings.

Survey Major Equipment

To facilitate economical plant operation in the winter months, a careful survey of the condition of the major equipment is advisable. In the experience of Bayuk Cigars Inc.—makers of "Phillies" cigars and in whose operations complete air conditioning is indispensable—it has been found valuable to enter the notations obtained from this survey in the tabular form illustrated. Other data can be entered on similar forms prepared for the actual system under consideration. The check-up may well include—

1. *All equipment for distribution and utilization of heat.* This should include the traps, hangers, drip pockets and return piping. Defective bellows and valves in traps may waste more steam than the entire unit puts to effective use. Cleaning of heater fins is distinctly beneficial.

2. *Source of air moistening effect.* Generally the maximum air saturation will now be required. A survey of the condition of pump packing, pump shafts, spray nozzle orifices and eliminators should be made. If air filters are employed, they should be examined, tested for resistance to air flow, and cleaned or replaced as required.

3. *Air motion and distribution of humidified air.* In many cases a lower air volume can be employed to advantage in winter. The means of making these adjustments—volume dampers, diffusers, etc.—should be gone over. Fan wheels and cones deserve close attention.

4. *Controlling, indicating and recording units.* Necessarily sensitive, all instruments must be protected from cold walls and excessive drafts and should be calibrated for best operation under winter conditions. Outside air dampers may be set to take in a decreased volume of air when in the fully open position. In any event, better results will be possible if automatic controls on these dampers are readjusted to provide their smoothest operation in the first 50 per cent of damper opening. If rubber diaphragms are employed in the control system it will be well to examine them and replace all units which have lost even a portion of their flexibility. Particular attention should be given all tempering coil controls, to avoid freezing. While all systems are not

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*Technical Director, Bayuk Cigars, Inc., Philadelphia, Pa. Member of Board of Consulting and Contributing Editors.

BAYUK CIGARS, INC.

FALL AND WINTER AIR CONDITIONING SURVEY
HEATING SYSTEM PORTION

Plant.................

Check each item separately—not as a group.
Keep this record in duplicate—Number or identify all parts.

Unit Description	Tested Date Initial and Note Extent of Test Made	General Condition	Last Previous Repair	Attention Required. Note Previous Experience	Expected Delivery of Parts —Date	Performance Dates		Repair Cost		Final Test and Approval Date
						Best	Actual	Parts	Labor	
Boiler Tubes—Sections or Shell..............										
Boiler Setting..............................										
Boiler Insulation...........................										
Return Traps, Piping and Pump...............										
Fuel Burners................................										
Fuel Storage................................										
Fuel Handling...............................										
Boiler Instruments, Gauges and Controls.......										
Protective Devices—Fuse Plugs, Water Feeders, etc....................................										
Breeching, Stack............................										
Boiler Room—Water Proofing, Drains..........										
Boiler Room—Wiring and Electrical Contacts....										

equipped for the type of control which automatically compensates for changes in outside weather, it will be found decidedly useful to at least provide outside thermometers at various critical and accessible points outside the building. Manual adjustments can then be made, and frequently the beneficial results of zoning control can be partially attained.

5. *Insulation.* All insulation should be minutely examined to insure its sound condition and that the protective coating is vaporproof. The diffusion rate of moisture is even more rapid than that of heat, and once moisture condenses inside any insulation costly disintegration and quick loss of efficiency occurs.

6. *General building structure.* Usually the greatest opportunity for improvement in operating efficiency will arise from attention given this feature and too great emphasis cannot be laid on careful preparation of the enclosure. In the writer's experience savings have been possible in every case where the building was reconditioned to make it more weatherproof at the beginning of the heating season. Frequently this amount will run up to 20 per cent of the fuel cost, without considering the improved control and comfort and product reactions obtained by more effectively excluding the outside air. Calking of window and door frames is inexpensive and highly productive. Some windows, doors and roof ventilators may be found which are not needed during the cold months, and these had best be closed tightly or possibly blanked off. The *A. S. H. V. E. Guide* shows that with a 5 mph wind velocity, 3.3 cu ft of air per hr will enter the building for each foot of wood window frame which is not calked, and that calking will reduce this figure to 0.5 cu ft— a saving of approximately 85 per cent. The same authority shows other inexpensive measures which yield comparable results.

7. *Electrical.* Wiring should be examined carefully, particularly those conduits and lines with which high dew point air comes in contact. If there is any reason to believe that condensation may collect on any electrical circuit, the lines must be relocated or insulated to avoid certain trouble.

8. *Lubrication and miscellaneous.* Any equipment which is not required to be in operation during the winter should be lubricated and set in motion at periodic intervals. If it is not practical to use power for this purpose, the rotors, pistons, etc. should be turned to new positions manually to avoid pitting. It is best to remove all shaft packing if the system is to be inoperative for any long period, and all bright parts should be thoroughly coated with a rust preventive. Any painting of cold surfaces which will later fall below the dew point of the surrounding air must be done at once, since the coating cannot adhere properly if applied in the presence of moisture. Naturally, water and other solutions in exposed piping and cooling towers should be completely removed to prevent damage by freezing.

Fall Overhauling and Testing

The necessary overhauling or major repairs on much equipment, such as refrigerating machinery, can be most conveniently and economically performed if done in the late fall, when rapid completion is not a controlling factor. The dated record system is advisable for all these general maintenance operations.

Those responsible for the operation of a year-round air conditioning system are quite likely, at this time of the year, to look forward with anticipation to a period when the manipulation involved in cooling and dehumidification problems need not be constantly in mind. It is extremely unwise to proceed on this expectation without careful analysis of the recent operation. The fall months represent the last opportunity for setting down the illuminating results of full load tests on cooling or refrigerating equipment and are, naturally, the first opportunity to make a thorough study of what may be expected from any system under high heat demands.

If the system has been used during the preceding winter, a careful review of that experience will be profitable. If not, as complete a test as possible should be run at the first opportunity. Capacities and guarantees can be checked by approximation, based on the operating settings required to carry the load under mild conditions. In some cases it may be necessary to conduct thorough heating or cooling tests on Sundays or other off days, and it will be found distinctly useful to do so.

Based on the author's observations, the time required for, and the cost of, repairs and proper adjustment on air conditioning equipment to permit operation at maximum efficiency are insignificant when compared with the improved results obtained. In practically every case the cost has been returned in a surprisingly short time.

Fundamentals of Joint Design for Welded Piping Systems

By S. C. Clark*

FROM the standpoint of sound engineering as well as of good economics, the simplest and the smoothest pipe joints are welded intersections between the ends of straight lengths of pipe—in other words, the butt type joint. Almost any conceivable joint between two pieces of pipe, where the outer cylindrical surface of one entirely intersects the other, can be welded if there is need for it. In practice, only certain forms of joint intersections between straight pipe are commonly used. Some of these are illustrated in Figs. 1, 6, and 7.

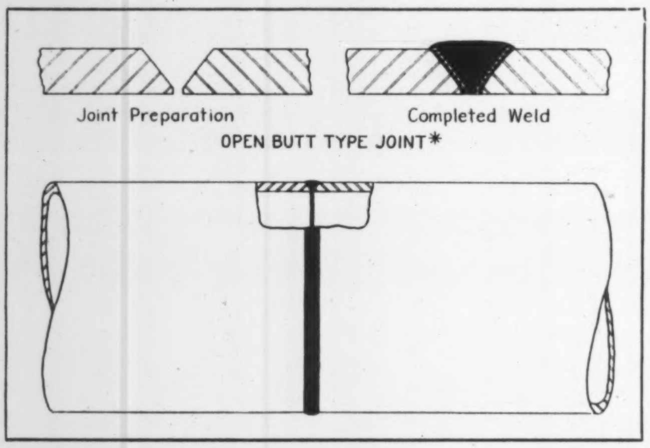


Fig. 1—Open butt type joint for piping

The most desirable form of weld for these intersection joints has been found to be one where the root or bottom of the weld extends to the inner wall surface of the main pipe. This provides a joint of maximum strength with a minimum amount of welding.

Complete piping systems fabricated from straight pipe are practicable and are often so installed. Curved or bent pipe and special welding fittings, however, lend themselves better to ideal piping design and are widely employed, especially in high pressure service and where flow efficiency is an important factor. These are usually installed by means of the simple butt type welded line joint. A variety of welded intersections are also possible between bent pipe, welding fittings, and straight lengths of pipe. Examples can be seen in Figs. 6 and 7.

Joint design involves both the weld cross-section and the form of the joint or fitting which is welded. It is the purpose of this article to consider in some detail the factors involved in the design of the weld cross-section for oxy-acetylene welded piping.

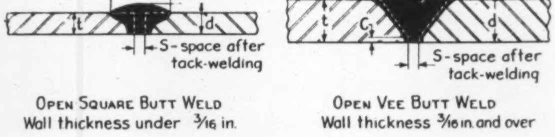
The Butt Type Weld

The theoretical strength of the simple butt type weld in wide use for pipe joints requires little discussion since the weld merely replaces a portion of the pipe wall cut away, becoming an integral part of the pipe itself. It is this fact that is largely responsible for the simplicity of joining pipe with the butt type weld. No more metal is cut away than is necessary to permit properly making the weld, and no special preparation for welding is required that cannot be done quickly with the oxy-acetylene cutting blowpipe. Further, the butt type joint is easy to weld because of its symmetrical shape. It also is easy to show that the butt type weld, by its very nature, provides the strongest and soundest joint obtainable with a given amount of weld metal.

In repair work, as in new installation, the open butt type joint makes possible a method of construction having remarkable flexibility. Sections of a piping system to be replaced can be removed with the cutting blowpipe, and a new section or fabricated piece welded back in place. This is done without disturbing in any way the pipe on either side of the cuts, often with greater ease than when replacing a flanged valve or fitting.

Requirements in Weld Design

Design of welds involves consideration of the requirements of base metal preparation and weld cross-section; both are shown in Fig. 2. It will be seen that base metal preparation for wall thicknesses $\frac{3}{16}$ in. and over is simply the beveling of the metal edges to an angle of 25 to 45


w
t
d
S-space after tack-welding
OPEN SQUARE BUTT WELD
Wall thickness under 3/16 in.
B
B
w
V
t
C
d
S-space after tack-welding
OPEN VEE BUTT WELD
Wall thickness 3/16 in. and over

STANDARD WELD DESIGN FOR LINE JOINTS

Welding Method	t	Bevel B	Shoulder C	Spacing S	Weld Depth d	Weld Width w
Single-Flame carburizing flame method Neutral-Flame Welding	under 3/16"	no bevel	-----	1/16 to 3/32"	1.2t to 1.5t	2t to 3t
Neutral-Flame Welding	3/16" & up	35°-45°	1/16 ± 1/32"	3/32 to 3/16"	1.1t to 1.3t	V + 1/8" to 3t
Single-Flame carburizing flame method	3/16 to 1/2"	30°-35°	1/16 ± 1/32"	1/16 to 1/8"	1.1t to 1.3t	V + 1/8" to 2½t
Multi-Flame carburizing flame method *	3/16 to 1/4"	30°-35°	1/16 ± 1/32"	1/16 to 1/8"	1.1t to 1.3t	V + 1/8" to 2½t
Multi-Flame carburizing flame method *	5/16 to 1/2"	25°-35°	1/16 ± 1/32"	1/16 to 1/8"	1.1t to 1.3t	V + 1/8" to 2½t
Single Or Multi-Flame Multi-Layer carburizing flame method	9/16" & up	30°-35°	1/16 ± 1/32"	3/32 to 5/32"	1.1t to 1.2t	V + 3/16" to 2½t

Fig. 2—Standard weld design for line joints

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*The Linde Air Products Co., New York, N. Y.

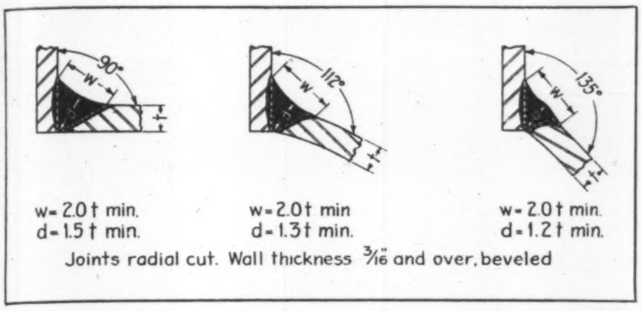

Fig. 3—Design of inside corner welds on branch connections

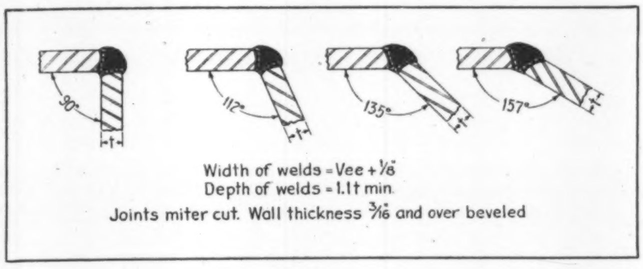
90°
112°
135°
157°
t
Width of welds = Vee + 1/8"
Depth of welds = 1.1t min.
Joints miter cut. Wall thickness 3/16" and over beveled

Fig. 4—Design of outside corner welds on turns

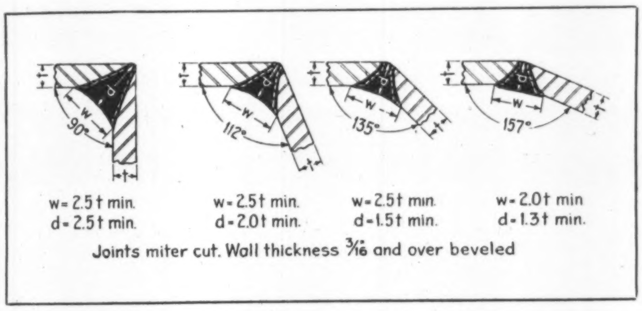

Fig. 5—Design of inside corner welds on turns

deg, which forms a vee to be filled in by welding. For wall thicknesses less than $\frac{3}{16}$ in. beveling is unnecessary because it is possible to secure fusion at the bottom of the joint with edges left square. A skillful operator can obtain good fusion on slightly thicker pipe with edges square, but welding is slower and more gases are consumed.

Angle of Bevel—The angle of bevel depends principally on the welding technique used. Experience has shown that a 60 to 70 deg vee gives best results when the carburizing flame method with backhand technique and a single flame is used. With the multi-flame carburizing flame method, a vee of 50 to 60 deg has been found to be satisfactory and more economical on pipe thicknesses $\frac{5}{16}$ in. to ½ in. Likewise, best results with neutral flame welding and forehand technique are obtained with a 90 deg vee. The expense of welding varies directly with the amount of welding rod deposited, hence a narrower vee—when allowed by the technique employed—means a lowered cost of welding for a particular pipe wall thickness.

Joint Spacing—In the designs in Fig. 2, provision is made for a gap or spacing between the metal edges, usually between $\frac{1}{16}$ in. and ⅛ in., during the welding operation. Primarily, the spacing facilitates thorough fusion of the weld metal with the pipe metal at the bottom of the vee. Some have the mistaken idea that this gap allows weld metal to sag within the pipe, but this is definitely not the case.

With the single vee weld, a sloping puddle of weld metal narrowing to a point at the front is employed. This permits the bottom of the vee to be welded together slightly in advance of the upper portions in the following manner: As the edges of the pipe at the bottom of the vee become molten, the advancing, shallow front of the welding puddle bridges across between the edges fusing them together. Surface tension of the molten metal prevents it from sagging inside the pipe and it solidifies almost immediately as the puddle advances, providing support for the more fluid metal in the center of the puddle. The open square butt type weld is made in a similar manner.

If the spacing is greater than ⅛ in. during welding, bridging at the bottom of the vee is aided by the end of the welding rod. This helps to keep the puddle less molten at that point and provides support by cohesive action. Since wider spacing requires extra rod manipulation and increases the cross-section of the weld, it is desirable in the interests of economy to hold the spacing to approximately $\frac{3}{32}$ in. at the point of welding.

Tack Welds—The spacing and joint alignment are controlled by tack welds—shallow welds about 1 in. long—made at intervals around the joint before welding is commenced. The tack welds contract about $\frac{1}{16}$ in. upon cooling, which means that the original spacing must be $\frac{5}{32}$ in. to $\frac{3}{16}$ in. or more. As welding is started and progresses around the joint, the space ahead closes slightly due to contraction of the weld. The space would close entirely but for the tack welds, so they are made at sufficient intervals to keep the spacing from becoming less than $\frac{1}{16}$ in. at any point. This permits gases from the flame to pass inside the pipe joint, facilitating welding of the vee bottom.

Weld Cross-Section—Reference to Fig. 2 will show that weld cross-section for butt type welds is largely determined by preparation and spacing of the pipe ends. Theoretically, when a welding method is employed assuring weld metal stronger than the base metal, the weld need only fill in the gap or vee between the pipe ends. However, a minimum reinforcement of 10 per cent in the case of single vee welds is specified because a truly flush weld is less easy to produce. The reinforcement also adds a slight factor of safety.

When the weld metal has a lower unit tensile strength than the base metal, reinforcement is necessary to insure a joint as strong as the pipe. A minimum reinforcement of 25 per cent is usually specified. Reinforcement in excess of 25 per cent does not add to the strength of the joint, unless the weld is increased sufficiently in width to maintain the slightly convex contour, an uneconomical practice.

Minimum weld width is set at the lowest dimension practicable with the welding operation. A width somewhat larger than this indicates excessive melting of the base metal, and while not necessarily detrimental to weld quality, it shows inefficient welding and is to be discouraged.

Penetration of the weld into the pipe ends, beneath the surfaces of the vee, depends largely on the welding technique employed. With the carburizing flame method, for example, it is quite possible to produce welds having no *noticeable* penetration, yet with perfect fusion between weld metal and base metal. This is not generally the case, however, and penetration of $\frac{1}{32}$ to $\frac{1}{16}$ in. with still more at the upper and lower edges of the vee is the normal result in ordinary practice.

Inside and Outside Corner Welds

Welded turns, welded branch connections, and certain other types of welded fittings (Figs. 6 and 7) contain what are known as corner welds, a variation of the butt type weld. (See Figs. 3, 4, 5, and 6.) A similarly economical use of weld metal is made in the design of these welds which develop the full wall thickness of the pipe joined, are regular in contour, and are produced with a welding technique very similar to that used for butt type welds. Considerations of joint preparation and weld cross-section are also essentially the same.

Beveling—Wall thicknesses $\frac{3}{16}$ in., and over should be beveled to give a vee of 70 deg where possible. With inside corner welds, where pipe walls meet at an angle of 90 deg, as shown at the left in Figs. 3 and 5, a vee of from 45 to 60 deg is the widest that is generally practicable.

Weld Dimensions—As a guide to the minimum amount of metal in the weld, the minimum dimensions of the weld expressed in terms of weld width and depth are given in Figs. 3, 4, and 5.

In the case of a header and branch of equal diameter the minimum dimensions of the weld vary from a width of 2 times the header wall thickness and a depth or throat of 1.5 times the header wall thickness where the pipe edges intersect at 90 deg, to that where the pipe edges are in line on the side and a butt type weld is made having a minimum width of the vee plus $\frac{1}{8}$ in. and a minimum throat 1.1 times the branch wall thickness. For branch and header of unequal diameter the weld dimension will vary within the above range, being a minimum of 2 and 1.5 times the header wall thickness for the width and depth respectively at the top and slightly less at all other points.

Fillet Welds

Fillet welds, several types of which are shown in Fig. 8, are used in connection with certain welded joints, and for welding on reinforcements such as pads and saddles. They are also used in piping systems as structural welds for joining anchors and supports to pipe and structural members. Fillet weld design for pipe joints and fittings is somewhat similar to the design of butt type welds. For structural purposes, however, quite different methods of design are in general use.

Strength—Fillet welds are utilized in resisting forces both in tension and in shear. At *A,* Fig. 8, for example, fillet weld *a* at the end of the upper bar is in tension under load, and fillet weld *b* is in shear. With these two welds having proper cross-section and length, the entire load which the upper bar is capable of carrying can be transmitted to the lower plate.

At *B,* Fig. 8, fillet weld *c*—in tension—can likewise transmit the entire load from the upper bar to the lower plate. This assumes that the weld metal is equal to or greater than the base metal in unit tensile strength. The assumption must also be made in the case of both *A* and *B* that during loading the bar and plate remain in full contact *since appreciable bending in base metal parts near a fillet weld reduces the strength of the joint.*

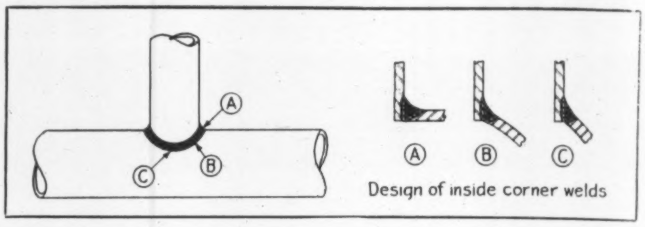

Fig. 6—Typical welded tee showing use of corner welds

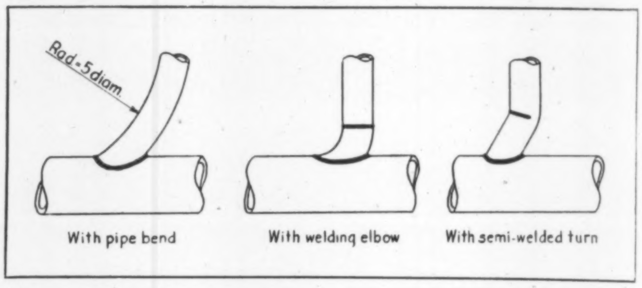

Fig. 7—Welded sweep tees

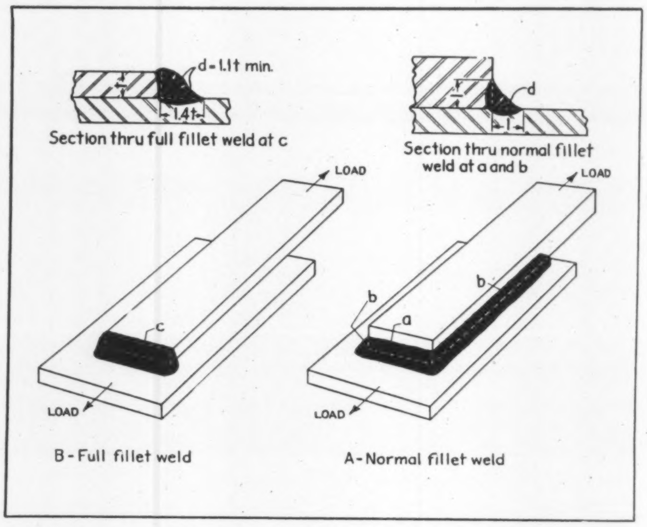

Fig. 8—Fillet weld design

The total strength of a fillet weld in shear or tension depends on three factors: (1) the throat (d); (2) the length of the weld; and (3) the unit strength of the weld metal in shear or tension, depending on which type of stress is being considered. Tests have shown that the unit strength of fillet welds in tension at the throat is equal to the unit strength of butt type welds in tension; that in shear the strength of fillet welds is approximately 87 per cent of their strength in tension; and that fillet welds in tension combined with fillet welds in shear (as in Fig. 8, A) also develop about 87 per cent of their strength in tension alone. This latter figure is somewhat conservative but is justified by the less ideal design of the fillet weld as compared to the butt type weld.

Fillet Weld Design for Pipe Fittings

Pipe fitting reinforcements such as saddles, rings, or pads are joined to the pipe with fillet welds.

The normal fillet weld is more economical to make for equivalent strength, and is used where the full tensile strength of the reinforcing piece need not be developed, or where a sufficient length of normal fillet can be placed in both tension and shear to develop full strength of the top piece, as in *A,* Fig. 8.

Full Fillet Weld—This is shown in cross-section at the top of Fig. 8. It is evident that this weld is suited to one particular purpose, that of transferring the tensile stress from the upper of two parallel plates in close contact, to the lower. Whether the plates are flat, or curved as in the case of pipe, is of little consequence.

The shape of the cross-section is determined by practical considerations. In other words, the cross-section shown for the full fillet has been found to have the smallest dimensions that will develop the full tensile strength of the upper plate, where the unit tensile strength of the weld metal is equivalent to or greater than that of the base metal. As with the butt type weld, the throat *d* should be increased to 1.25*t* if low carbon rod is used on ordinary low carbon steel plate, to provide a minimum reinforcement of 25 per cent.

Normal Fillet Weld—The cross-section of the normal fillet is almost always in the shape of a right triangle, and, other factors being constant, its strength is determined by the length of the throat *d* as explained previously. For other than right triangles, the throat *d* is the shortest distance from the root to the face of the weld—the face being the part of the weld that is seen. If the weld is reinforced, that is, if the face is rounded or convex, the weld is given additional strength in shear, equivalent to the lengthening of *d,* but little or no strength is added if the weld is in tension. To make reinforcement effective in tension, the lower leg *l* would have to be increased to 1.3 times the upper leg *l* (the leg at the end of the upper plate) so as to resemble the full fillet.

Developing a Code for Comfort Air Conditioning

By **L. A. Harding**[*]

Because comfort air conditioning codes for several cities are now being developed, and codes for many other cities are being considered, the editors asked Mr. Harding, who was chairman of the committee, to prepare this brief "behind the scenes" story on the recently adopted Buffalo air conditioning standards

THE committee appointed by the Western New York Chapter of the *A. S. H. V. E.* which developed the Buffalo comfort air conditioning code[1] spent considerable time and effort in ironing out various differences in opinion of local interests in reference to the items to be covered by such a code as well as the material to be included under the various headings. Use was made of various existing *A. S. H. V. E.* codes as well as codes adopted by other national engineering societies.

The committee originally placed the outside design temperature conditions as 88 F dry bulb with 73 F wet bulb, corresponding to 49 per cent relative humidity and 36.03 Btu total heat; this combination is rarely ever exceeded at noon in Buffalo. The inside design temperature conditions were originally designated as 78 F dry bulb with 65 F wet bulb corresponding to a relative humidity of 50 per cent and 29.65 Btu total heat, the difference in total heat per lb being 6.38 Btu. There was some objection to the 88 F dry bulb outside temperature, this being considered too low by several vendors of air conditioning equipment.

The design temperature conditions for cooling as finally adopted are, outside condition, 95 F dry bulb; 75 F wet bulb; 39 per cent relative humidity; 37.81 Btu total heat; inside condition, 85 F dry bulb; 67 F wet bulb; 39 per cent relative humidity; 31.15 Btu total heat, the difference in total heat per lb being 6.66 Btu. It is apparent that this change in the design conditions makes but little change in the design load.

It was not considered of sufficient importance to provide a dual standard for design temperature conditions. It would appear to be an unnecessary complication to base inside design temperature conditions on effective temperature, as determined by the *A. S. H. V. E.* comfort charts. This scheme, advocated by some, obviously permits of a considerable leeway in the design inside wet bulb temperature resulting in a difference in the estimated design load.

The scheme of classifying various kinds of comfort installations, based on assumed time of occupancy, in conjunction with effective temperature with minimum and maximum relative humidities in no way removes the possible variation in estimated loads, as may be obtained by engineers employing the code. The committee thought it best to eliminate, insofar as possible, opportunities for a permissible variation in design load computations. If the owner is provided with apparatus of adequate capacity, he naturally will operate the equipment to suit the varying load conditions, which have little or nothing to do with design conditions.

The minimum design inlet air temperature, or 60 F, is 2 F above the design room dew point temperature, 58 F.

It was thought best to include a table of fixed percentages to be added to the estimated sensible heat load and not the total load. The increase in load during the starting up periods is believed to be largely due to an increase in the room sensible heat load, rather than an increase in the latent heat load.

The committee was of the opinion that a minimum requirement in reference to noise control had best be deferred until such time as the *A. S. H. V. E.* adopts a standard method of test procedure including acceptable apparatus to be employed in this connection.

When guarantees of performance are requested by an owner's representative, the owner is necessarily responsible for reproducing the design load conditions within reasonable limits, as the contractor obviously has no control over this matter. The object of calling attention, in some detail, to performance guarantees to be proved by field tests is the fact that some architects and engineers do not fully appreciate the division of responsibility in this connection.

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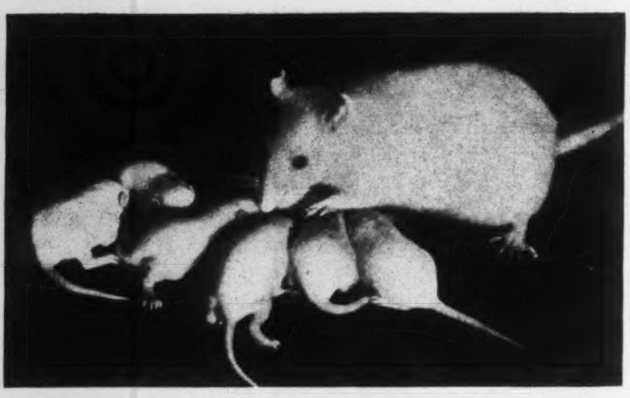
[1] Published in *A. S. H. V. E. Journal Section,* HEATING, PIPING AND AIR CONDITIONING, September, 1936, pp. 519-521.

[*] L. A. Harding Construction Corp., Buffalo, N. Y. Member of Board of Consulting and Contributing Editors.



Even Rats Are Air Conditioned!

By Paul W. Watson

IN manufacturing pharmaceuticals it is necessary that products be tested carefully; some can be tested chemically, but the strength and purity of many can only be determined by literally "trying them on the dog"—or cat, or rat, or guinea pig. This is known as a bio-assay.

Bio-assay necessitates the use of thousands of experimental animals. Several generations may be used in a single test, or in testing a single product from time to time; consequently every means must be used to produce animals as nearly alike as individual biological entities can be.

This was the chief reason the Abbott Laboratories, Chicago, air conditioned their animal house. For instance, there are two rooms devoted to breeding white rats for vitamin assays, and during the first six months of last year 10,000 rats were produced in this breeding colony. However, if not even the atmospheric conditions surrounding these rats could be controlled, who could say that they were "standard animals"? A rat born and raised in the heat of summer certainly lived under different conditions than one born in winter, and a rat who had had the "sniffles," or pneumonia, induced by being chilled, could not be classed with one that had a healthy life. By air conditioning, the white rat was to be given an environment favorable to his growth and development—and the conditions under which he lived were to be identical with the conditions under which his great-great grandchildren would live.

Another object in air conditioning the animal house was to eliminate, as far as possible, odors. This was done by providing for an ample supply of outside air.

Precautions were also taken to eliminate dust and to prevent particles of the diet of one animal from being carried away by the air and deposited on the food of another group of animals undergoing a different type of test. Such possible contamination is prevented by air filters installed in all of the return grilles in each room. With the exception of the small amount of air that might drift under the door, or through the door when opened, the air leaving any one room is filtered before it enters the exhaust duct or the corridor. A further precaution was taken with the feed storage rooms, for there the doors were calked with rubber strips.

The air conditioning system was designed to maintain about 75 F dry bulb and 55 per cent relative humidity, with a temperature variation of not more than plus or minus 1F, and humidity to be controlled to within plus or minus 2 per cent.

In calculating the cooling load, no data were available on the rats. The Btu rate for a man (assumed to weigh 150 lb) was therefore taken and the weight of the rats totalled. Each 150 lb was considered equal to one human, and a 25 per cent safety factor was added.

A "Freon" compressor driven by a 50 hp motor furnishes refrigeration, but the machine is not running at its maximum capacity as it was selected for enough capacity for air conditioning the second floor, if and when that addition is made. A closed type multi-water-pass shell and tube condenser liquefies the refrigerant, which is then fed to serpentine direct expansion coils in the air washer. A float control regulates the flow of refrigerant to the coils. The air washer is of standard design complete with inlet deflectors and eliminators.

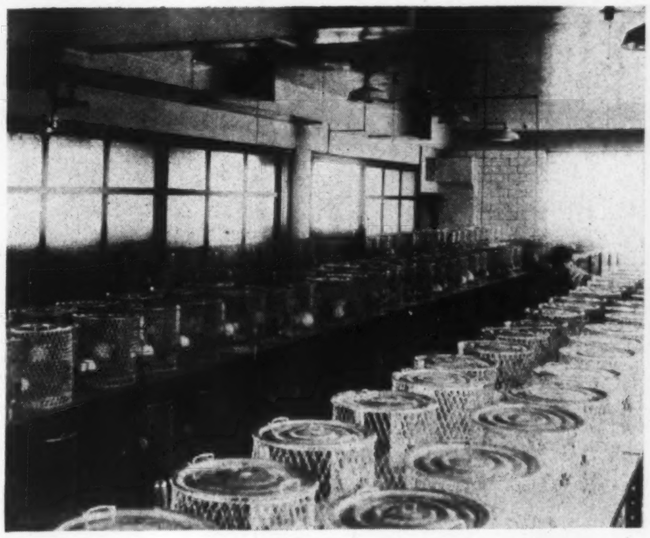
The dew point of the air is determined in the air washer. Reheating coils add heat when necessary and take care of the bulk of the heating load. However the final determination of the amount of heating required for each room is taken care of by a booster heater placed in the air duct ahead of the outlet grille in each room. A thermostat in each room controls the admission of steam to the booster heater so that it is possible to vary the temperature in each one of the rooms independently.

Control was carefully worked out. There is a bypass on the compressor which makes it possible to operate the machine at 50 per cent capacity when loads are light. The control of the refrigerating machine depends upon the temperature of the spray water, the compressor starting and stopping as the refrigerating requirements vary. Two dampers admit outside air; one is manually controlled and the other is automatic.

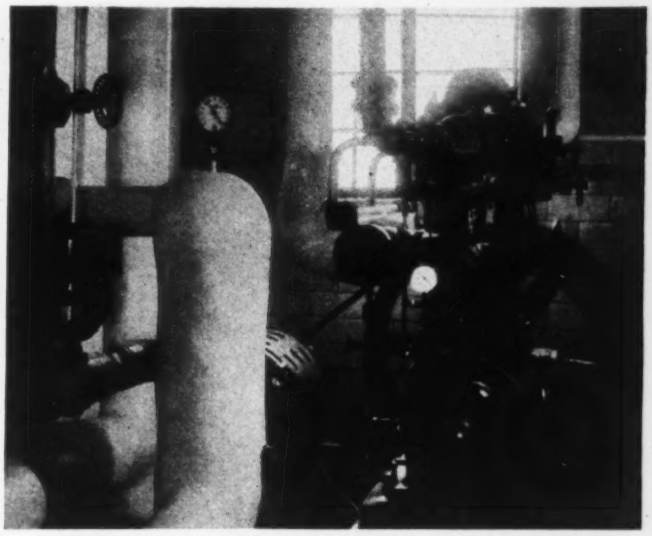
The system provides for bypassing or recirculating of a certain amount of air depending upon the temperature and humidity requirements. The first floor, which at

One of the thermostats

Air conditioning serves many industries in many ways. An interesting application in the manufacture of pharmaceuticals is eliminating environmental variables to make possible the breeding of rats, thousands of which are used in testing the product, under standard conditions.



Some of the cages



A "Freon" compressor is used

present is air conditioned, is handled by about 11,300 cfm.

It was found advisable to install a master thermostat in the entrance hall that would record any variation above or below certain points by turning on a red light. The watchman was then given the telephone numbers of those he must call in the event that the red light glowed.

The help of Mr. C. G. Quermann of Westerlin and Campbell, Chicago, who were responsible for the design of this system, is gratefully acknowledged.

CONTROLS

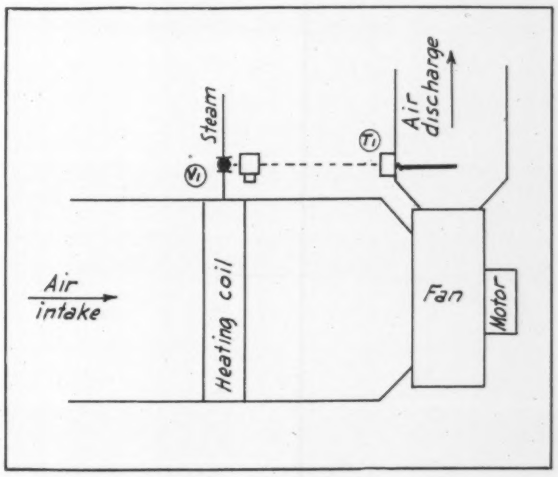
By C. L. Ringquist*

Reference Sheet 2

Although data on electrical controls for heating, humidifying, dehumidifying, ventilating, cooling and complete air conditioning may be had from numerous sources, information on groups of controls applicable to various types of systems is not so readily available. The author has therefore diagrammed typical control layouts, with each of which is given an explanation of the control cycle. . . . For the purpose of illustration, central fan coil types of systems are used; the control arrangements described are equally applicable to units built up to perform the same functions. . . . Types of systems covered by this series include humidifying; ventilating; heating and ventilating; heating, ventilating and humidifying; cooling, dehumidifying and ventilating; cooling, dehumidifying, ventilating and humidifying; heating, ventilating, dehumidifying and cooling; heating, ventilating, dehumidifying, cooling and humidifying; and zone control systems.

VENTILATING

Simple Ventilating System, comprising Outside Air Intake, Heating Coil, Fan, Motor, Discharge Duct and Controls:



Symbols

T_1	Modulating type duct thermostat
V_1	Modulating motorized valve

Cycle—T_1 set to maintain a constant air discharge temperature (usually 75 to 85 F), acts to modulate V_1, which governs the amount of steam allowed to enter the heating coil and thus the amount of heat supplied to the air passing through the coil.

Care must be used in selecting the coil and valve so that at entering air temperatures below 40 F, the entire coil is filled with steam, thereby preventing freezing of the condensate in the coil.

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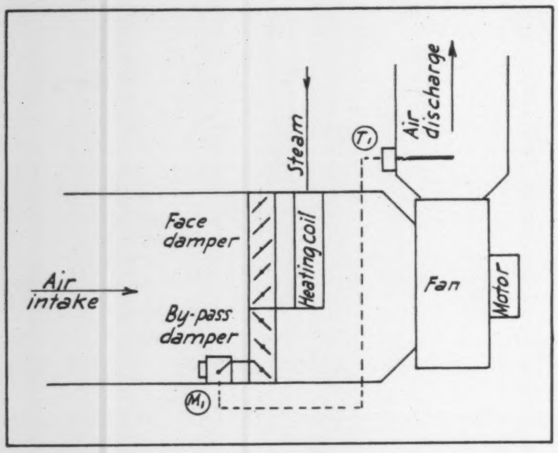
*Air Conditioning Department, The Trane Co., La Crosse, Wis.

The fan and motor on this simple type of system are generally controlled manually and are in continuous operation whenever ventilation is required.

No heating is supplied, the air being tempered only to prevent drafts.

Heating Coil in Conjunction with a Set of Face and Bypass Dampers, together with Fan, Motor, Discharge Duct Work and Controls to Deliver a Predetermined Amount of Tempered Outside Air to the Space to be Ventilated:



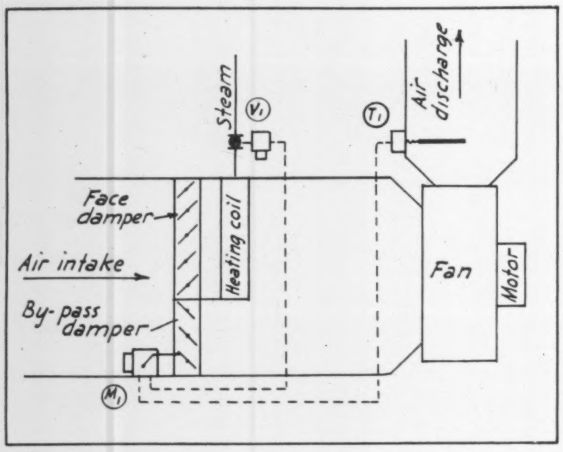
Symbols

M_1	Damper motor
T_1	Modulating type duct thermostat

Cycle—T_1 controls the action of M_1 which in turn determines the position of the face and bypass dampers. The position of these face and bypass dampers determines the amount of air passing through and around the heating coil. The amount of air passing through the bypass will depend upon the amount of heat required to raise the temperature of the incoming air to the final temperature as required at the discharge side of the fan.

No control is provided on the heating coil or the fan and motor.

Same as Preceding Example, with the Addition of a Positive Shut-off Valve in the Steam Supply to the Heating Coil:



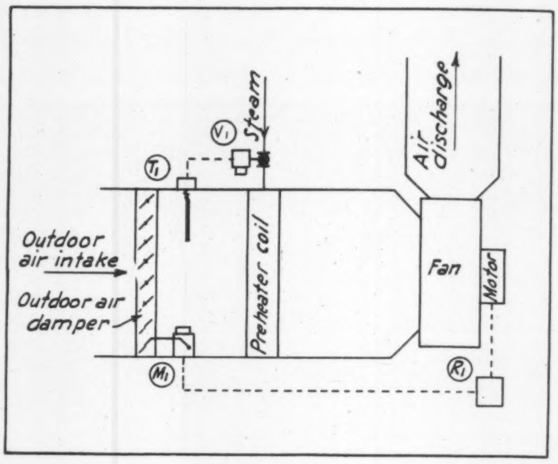
Symbols

M_1	Damper motor
T_1	Modulating type duct thermostat
V_1	Modulating motorized valve

Cycle—T_1 controls the operation of M_1, which operates the face and bypass dampers to allow more or less air to pass through the bypass in order to maintain constant temperature at the fan discharge as called for by T_1.

M_1 is equipped with an auxiliary connection to V_1 which acts to modulate V_1 when the face damper is closing and some of the air is being bypassed. This modulating of the steam supply to the coil prevents overheating on extremely mild days, when air currents from the hot coil would tend to increase the air temperature when not required.

Simple Ventilating System, Usually Used in Cooperation with a Booster System of Heating or Providing Tempered Air to Additional Fan Systems:



Symbols

M_1	Damper motor
R_1	Relay
T_1	Duct thermostat
V_1	Two position motorized valve

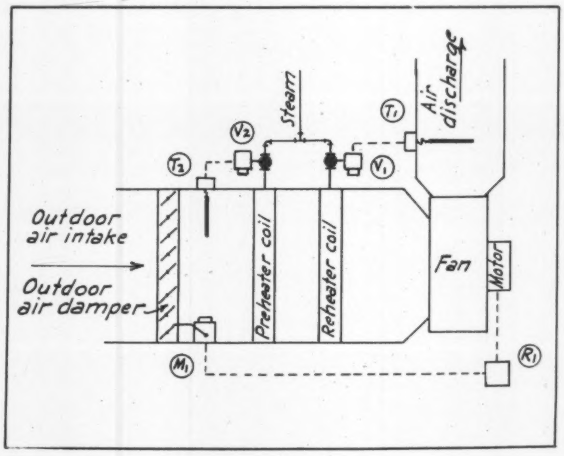
Cycle—M_1 controls operation of outside air intake damper. R_1 controls M_1 so that whenever the fan motor is not in operation, M_1 closes outside air damper, and immediately upon starting of the fan motor, outside air damper is opened to the full open position.

T_1, usually set at a predetermined temperature, controls V_1, opening it full open upon drop in temperature below setting on T_1 and closing fully upon rise in temperature above setting of T_1.

No accurate control is maintained on the discharge air, the required reheating being accomplished by booster heaters or direct radiation in the ventilated space.

Ventilating System Delivering Air at Constant Temperature for Ventilation Requirements Only, Similar to Preceding Example Except that a Reheating Coil is Incorporated to Maintain Constant Final Temperature from Fan Discharge:

The equipment incorporated into this setup consists of a set of outside air dampers, a preheater coil, a reheater coil, a fan, a fan motor, discharge duct work and controls as shown.



Symbols

M_1	Damper motor
R_1	Relay
T_1	Duct thermostat
T_2	Duct thermostat
V_1	Modulating valve
V_2	Two position motorized valve

Cycle—M_1 opens outside air intake damper by means of R_1 whenever fan motor is placed in operation. When fan motor ceases to operate, M_1 returns damper to fully closed position.

T_2 controls operation of V_2 and is usually set just above the freezing temperature of the condensate in the coil.

T_1 acts to maintain a constant leaving temperature by opening or closing V_1.

V_2 should be of the two position type, that is, either entirely closed or wide open, to prevent freezing of the preheater coil.

Heating·Piping
and Air Conditioning

1895

American Society *of* Heating *and* Ventilating Engineers
JOURNAL SECTION

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Condensate and Air Removal Rates in a Vacuum Heating System

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THIS paper reports the results of a study of the air and condensate loads in the heating system returns of the Mechanical Engineering Building at the University of Wisconsin, an exterior view of which is shown in Fig. 1. A single story portion between the two wings houses the heating and ventilating laboratory which has been described in a previous paper.[1] The present study is on the returns from the vacuum system of the entire building, including this single story section used in the previously reported tests on the three heating systems. Observations were made during the heating seasons of 1934-35 and 1935-36.

Fig. 1—Photograph of Mechanical Engineering Building at the University of Wisconsin

Description of Heating System

The main part of the building has a total of 26,244 sq ft of equivalent direct radiation, made up as follows: 5,709 sq ft of cast-iron radiation in classrooms and offices; 1,421 sq ft of wall radiation in stairways and corridors; 7,566 sq ft of EDR in 28 unit heaters in various laboratories; 4,128 sq ft of EDR in 8 unit ventilators in the auditorium, conference and wash rooms; and 7,420 sq ft EDR in cast-iron blast coils for the classroom ventilating system.

The classroom and office radiation is on two temperature control which lowers the temperature setting to 50 F from 5 p. m. to 5 a. m. The radiation in stairways and halls is manually controlled, as is the starting and stopping of the central fan and unit heaters. The fan system, unit heaters and ventilators are all under single or continuous thermostatic control.

The heating system of the saw-tooth single-story section consisted originally of cast-iron radiation of the wall type placed along the walls under windows and below skylights. The system has been altered to the extent of adding seven suspended unit heaters, and two floor unit heaters with short branches from the original system. These are thermostatically controlled as three separate systems, any one of which may be operated. The cast-iron direct radiation is about 4,430 sq ft, the suspended unit heaters 4,318 sq ft EDR and the floor unit heaters 3,790 sq ft EDR. This is a total of 12,538 sq ft connected to the system with about one-third in active use at any one time. The remainder is open to the returns at all times and acts as a reservoir for air and contributes to the air leakage into the system to a certain extent.

The total connected equivalent direct radiation based on a 240 Btu emission factor is 38,782 sq ft, with about 30,500 sq ft in active use at any one time. The internal volume of the supply piping is about 590 cu ft, and that of the returns 74 cu ft. Cast-iron direct radiation internal volume is 186 cu ft, and for all other units including the blast coils it is estimated to be 22 cu ft. This is a total internal volume of the system of 872 cu ft.

The supply of steam is through a tunnel from the central heating plant where it is generated at about 150 lb per sq in. gage and reduced to about 10 lb per sq in. gage before entering the tunnel mains. A further reduction in pressure to about 3 lb per sq in. gage takes place at the building entrance by means of a reducing valve. The steam laboratory located in the east wing is supplied with steam at boiler pressure for engine tests, and the condensation loss in this pipe line enters the return line of the heating system. The heat loss from this main, of course, is useful heat during the heating season.

The returns terminate in a 4 in. pipe at the vacuum pump located in the basement of the front section of the building. The condensate is pumped from here through 300 feet of 2 in. pipe to the tunnel entrance, where it passes through two condensation meters in parallel, each having a capacity of 12,000 lb per hour. It then is pumped back to the central heating plant by a direct acting steam pump. The vacuum pump was rated by the manufacturer for a system of 65,000 sq ft and a

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[1] Tests of Three Heating Systems in an Industrial Type of Building, by G. L. Larson, D. W. Nelson and John James, A.S.H.V.E. JOURNAL SECTION, *Heating, Piping and Air Conditioning,* November, 1934.

For presentation at the 43rd Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, St. Louis, Mo., January, 1937.

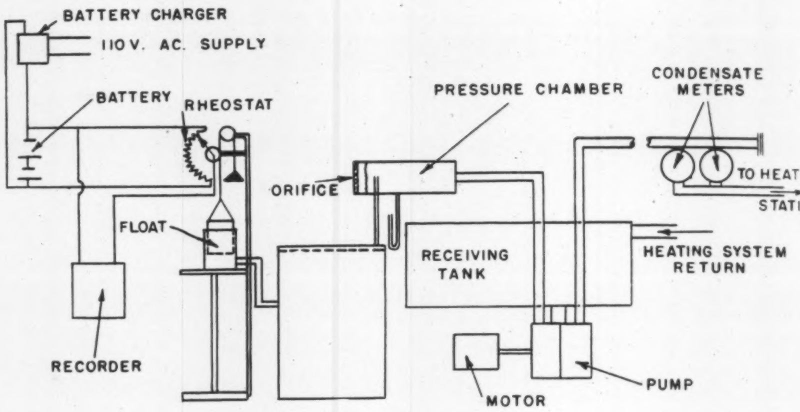

Fig. 2—Arrangement of test equipment for condensate and air removal tests

capacity of 90 gpm and 34 cfm at a 10 in. vacuum.

Test Arrangement

An arrangement used in observing the air and condensate loads is shown in Fig. 2. The air discharge was piped into a pressure chamber made of a 30 in. length of 6 in. pipe from which it reached the atmosphere through a 1 in. thin-plate sharp-edge orifice. The pressure on the orifice lifted a float attached to a rheostat. This varied the voltage to a recording volt meter which was supplied with a constant source of current through two six-volt storage batteries in series which were continuously charged by a trickle charger. The recording chart was moved at the rate of 3 ft per day and gave a record of pressures across the orifice and running periods for the vacuum pump. The system also was equipped with a recording pressure gage on the end of the steam main and a recording vacuum gage on the end of the return main, both of these being near the vacuum pump. In addition, manometers were installed to check these pressures and the pressure on the orifice.

For continuous tests of steady operation over a period of days, the condensation meters were read at frequent intervals and a calibration factor secured between running times of the pump as shown on the voltage recorder and condensation as shown on the condensation meter dials to apply at times inconvenient for observations, such as at night. This was found to give accurate checks so that a special recording device was not devised for the condensation meters.

During observations of peak conditions occurring during the first hours when steam was turned into the cold system, readings of all values were taken directly at 1 min intervals by five observers; three located in the pump room and two in the tunnel entrance.

Operation of Vacuum Pump

The three vacuum charts in Fig. 3 give a general picture of the operation of the pump. The chart at the upper right, starting at 5 p. m., April 5, shows the behavior in normal operation. This chart shows that during the night, operation on vacuum trip occurred every 1¼ to 1¾ hours with rather frequent short periods of operation to remove condensate on float control in between these longer runs to remove air. The vacuum trip cut in at about 3 in. Hg and out at about 8 in. Hg, during which time any condensate in the receiving tank was discharged. The running times on float control were found to average very closely to 20 sec in duration during the past season. During the previous season the float was adjusted to a shorter travel, which resulted in operating periods of 12 sec. The amount of condensate removed during each operating period on float control would be the receiving tank capacity between the cut in and out levels plus any additional amount entering during this short period of operation.

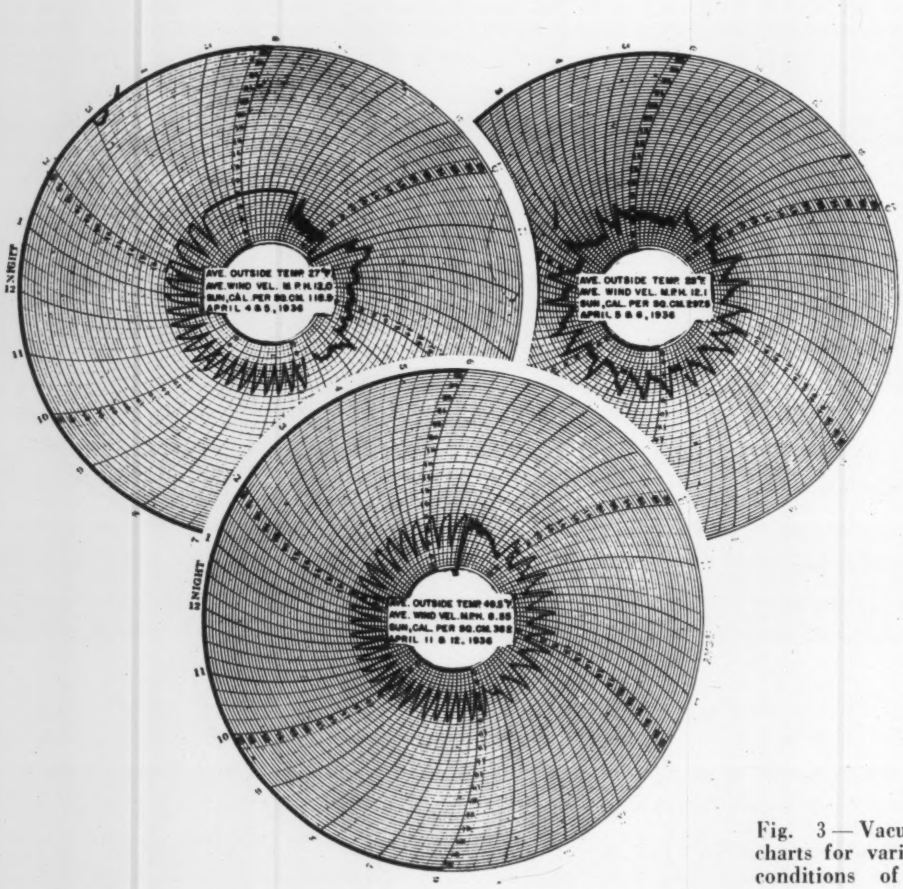

Fig. 3—Vacuum recorder charts for various operating conditions of the system

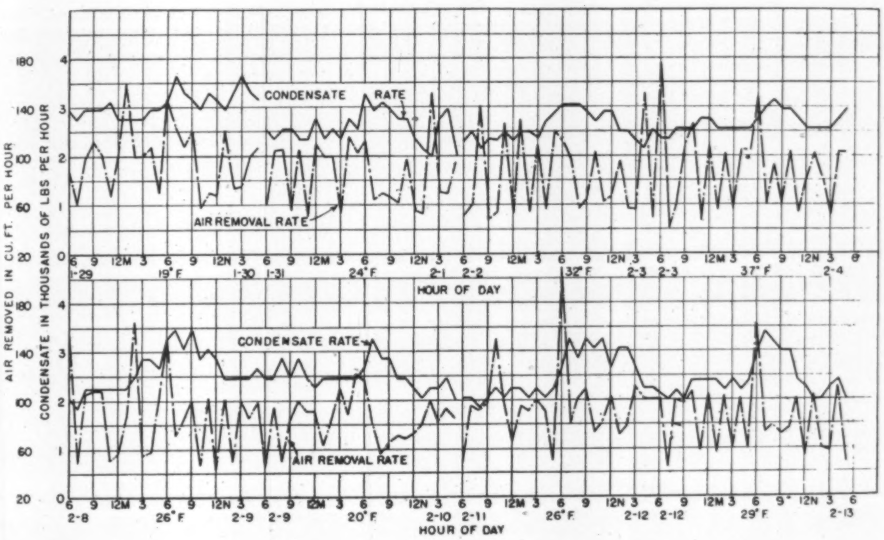

Fig. 4—Condensate and air removal rates for eight typical days

The chart for April 5-6 in Fig. 3 shows a warming up period of almost 3 hours with many short float controlled runs following the change to day setting of the two temperature controlled radiation in the classrooms, offices and in the heating and ventilating laboratory. The operation on vacuum trip occurred at intervals of about 1 hour during the day with four or more operations on float control in between for condensate removal. Of course, air was also removed during the float controlled periods, and if this type of operation were frequent enough to maintain the vacuum, no vacuum trips would occur. If the air removed was in excess of air in the system, the vacuum would rise above the normal range and the vacuum breaker would introduce air from the atmosphere. This condition was not observed at any time, although an erratic condition was found on April 5 as shown on the upper left chart of Fig. 3. The main valve on the low pressure supply main into the building was closed the night before at 5 p. m. and at 8 a. m. the valve was opened. After a short period of operation, the pump operated on cycles of only a few seconds' duration and yet the vacuum in the receiver tank increased to 14 in. Hg, which caused the vacuum breaker to introduce room air. This difficulty was found to be due to a clogged strainer, and when it was cleaned shortly after 10 a. m. the pump resumed normal operation. The two upper charts are for consecutive days with similar weather conditions and indicate a difference in air leakage, depending upon whether the steam was on or off. On the night of April 5 the steam was on the mains and in the various heating units except as prevented by the lower temperature settings for the two temperature controlled units. The pump operation was similar to a typical day operation with short float controlled runs in between vacuum controlled runs. On the night of April 4 the steam was shut off from the entire heating system. As the system and building cooled down, the pump operated at increasingly longer intervals in order to remove the leakage air to maintain the vacuum between 3 and 8 in. Hg. From shortly after 4 a. m. to 8 a. m. the pump ran continuously without approaching the cut-off vacuum. This shows a decided increase in air leakage as the system cooled down, although a survey of the building did not disclose any noticeable air leaks.

The single story section was built 15 years ago, whereas the main building system was installed in 1930. It is known that the wall radiators in the older section, which have as many as 28 sections, are not particularly tight. However, unit heaters were being used for heating during this period; consequently, these radiators were without steam during both of these nights. The air leakage varied during these nights when the steam was off for some unknown reason. The lower chart of Fig. 3 indicates less air leakage than in the upper left chart as shown by the fact that it was not necessary for the pump to run continuously. The steam was quickly turned on shortly before 7:30 a. m. with a resulting fall in vacuum to a positive pressure in the returns followed by frequent operation on float control until 9:30 a. m. This condition will be discussed in connection with Fig. 8. Operation during the day was at ¾ hour intervals on vacuum trips with two float controlled runs in between these longer runs. The weather on this day was considerably milder than on the other two days shown in Fig. 3.

Observations Under Normal Operation

The hourly condensate and air removal rates for the system on 8 typical days are plotted in Fig. 4. In general, a peak of air removal occurs after 5 a. m. each day when the radiation is shifted from night to day thermostatic setting. The highest of these peaks occurred on February 12 and amounted to 210 cu ft per hour. In each case the air removal peak leads the condensate removal peak so that the two do not coincide. The highest condensate peak occurred on January 30 and amounted to 3,600 lb per hour. The average condensate and air rates for each of these days are tabulated in Table 1, together with the ratio of these rates to the

Table 1—Condensate, Air Removal Rates and Load Factors for Normal Operation

Date	Average Outside Temperature Deg F	Condensate		Air Removal	
		Rate in Lb per Hour	Load Factor[a]	Rate in Cu Ft per Hour	Load Factor[a]
Jan. 29-Jan. 30	19	3055	0.0673	97.20	0.0481
Jan. 31-Feb. 1	24	2628	0.0581	83.75	0.0415
Feb. 2-Feb. 3	32	2552	0.0567	82.80	0.0410
Feb. 3-Feb. 4	37	2669	0.0593	88.80	0.0440
Feb. 8-Feb. 9	26	2610	0.0580	88.40	0.0438
Feb. 9-Feb. 10	20	2490	0.0554	83.20	0.0412
Feb. 11-Feb. 12	26	2475	0.0550	94.20	0.0461
Feb. 12-Feb. 13	29	2410	0.0536	82.6	0.0409
Average	26.6	2614	0.0579	87.62	0.0433

[a] Based on a condensate capacity of 90 gpm and an air capacity of 34 cfm. Values not corrected for vacuum variations.

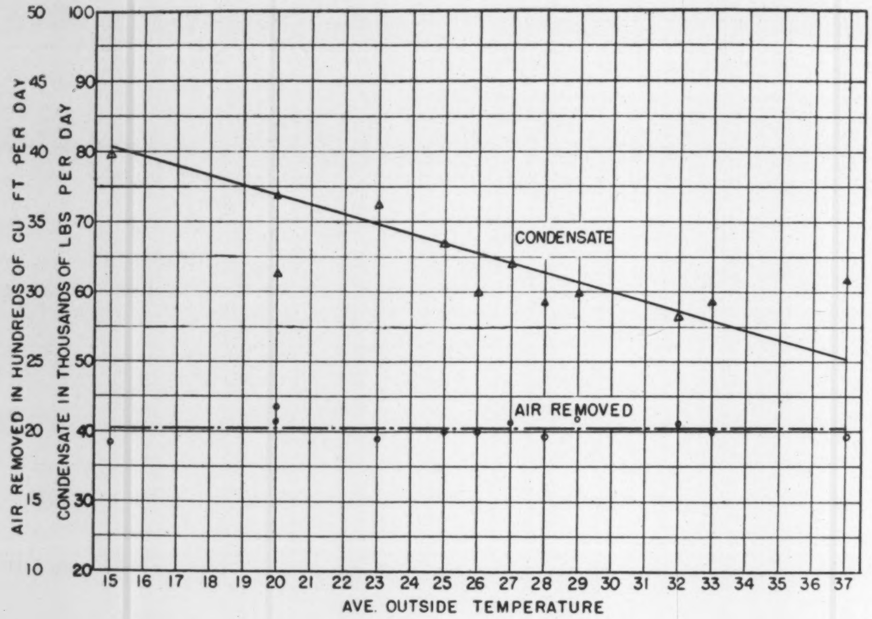

Fig. 5—Relation between condensate and air removal rates and outside temperatures

rated capacities of the pump. For the 8 days the average air removal rate was 4.3 per cent of the rated capacity and the similar comparison on condensate was 5.8 per cent.

The daily condensate and air removal rates for 12 typical days are plotted in Fig. 5. This chart indicates that the air removal rate was not influenced by the outside temperature but remained substantially constant over a range from 15 to 37 F. As discussed in Fig. 3, turning the steam off from the system materially increased the leakage. Since the radiators remain cold for increasingly longer periods under thermostatic control as the outside temperature becomes higher, the air removed might be expected to increase, giving an upward turn to the curve if extended to the right.

The system was designed for an outside temperature of —15 F. The condensate curve when extended indicates a steam consumption of 120,000 lb per day under this design condition. This is equivalent to 20,000 sq ft of EDR as compared to a normal capacity of the system of 30,500 sq ft. Since the fan system is used only during the day time, this condition and the lowered thermostatic setting on part of the system at night time would account for this difference.

Peak Load Observations

The maximum condensate and air removal rates naturally occur when steam is turned into a cold system. In order to study these peak load conditions, the steam was turned off at 5 p. m. and on again early the next morning. Typical results are shown in Figs. 6, 7 and 8, which give the condensate and air removal rates, the vacuum in the return line, the differential pressure from the steam line to the return line and the periods of pump operation. All readings were taken at 1 min intervals, but for satisfactory plotting 3 min periods were used.

The gate valve in the 8 in. line at the tunnel entrance was opened over a period of 30 min for the test represented in Fig. 6. No attempt was made to calibrate the effective opening of the valve against turns of the hand wheel. Also the reducing valve, which was set to maintain 3 lb per sq in. on the building system, may have influenced the effective opening. The peak for air removal, which was 1,825 cu ft per hour, was reached in 12 to 15 min. The pump ran continuously on vacuum control for 27 min. Considering the initial clearing of the air in the system extending until the pump stopped at 57 min, approximately 900 cu ft were removed, which is about equal to the internal volume of the system. Leakage under vacuum during this peak period would tend to raise the air removed above the internal volume of this system, but this would be counteracted by the air in the system being under less pressure therefore, shrinking in volume when measured at atmospheric pressure.

The condensate peak of 9,300 lb per hour came at 33 min, which is 18 min behind the air removal peak, and lasted for 33 min before fairly normal conditions existed. All of the pump operations except the first two were caused by float control, but the simultaneous removal of air was at such a rate as to maintain the vacuum quite constant around 7 in. Hg. The pump operated 30 per cent of the time in the 2 hours following the turning on of the steam. Weather conditions were uniform for the day preceding and the day of test, March 21 and March 22, and averaged 42.5 F, with a sun intensity of 285 cal per square centimeter and a wind velocity of 9.5 mph.

The valve was presumably opened at the same rate of 30 min for full opening on March 8 for the test shown in Fig. 7. The outside temperature was 32 F, the sun effect 292 cal per square centimeter and wind velocity 7.5 mph for this day and the preceding day. The vacuum dropped to about 2 in. Hg at the air peak period which was 12 to 15 min after the time of starting to open the valve. At this time the differential pressure between the end of the supply main and the pump end of the return dropped to zero, which meant that all traps were probably still open because steam had not reached them, and steam was not being supplied at a sufficient rate to build up a positive pressure in the steam mains. The air removal peak of 2,175 cu ft per hour was reached in 15 min as was that shown in Fig. 6. Considering the peak lasting until 60 min, 1,000 cu ft of air were removed. The condensate peak was high at 27 min after the starting of the opening of the steam valve, but the real 3 min peak of 12,000 lb per hour occurred at 36 min, which checks closely with the 33 min found in Fig. 6. The 1 min peak was 13,800 lb per hour. The ending of the peak period is rather indefinite, but probably was at about 60 to 80 min. All of the 25 pump operations in the first 2 hours, except the initial one of 27 min and the next two shorter ones, were under float control. The vacuum was maintained at a higher level than in the test shown in Fig. 6 and increased somewhat towards the end of the 2-hour period due to the more frequent running of the pump. The con-

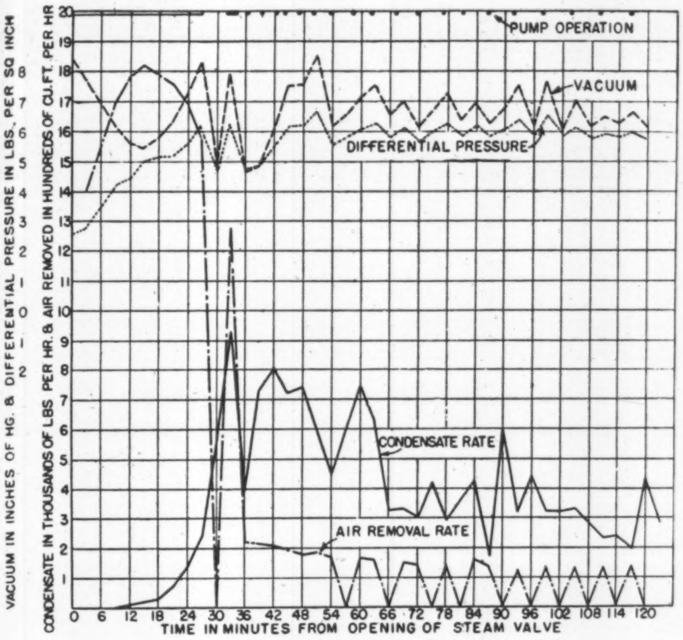

Fig. 6—Peak load test for March 22, 1936, with slow opening of steam valve

densate rate for steady operation shows about 4,600 lb per hour in Fig. 7 and 3,600 lb per hour in Fig. 6.

On several days the steam valve was opened quickly instead of over a period of 30 min as was done for the tests in Figs. 6 and 7. This resulted in a much higher air peak. The results of one of these tests taken on April 12 are shown in Fig. 8. The vacuum in the return dropped from above 8 in. Hg to ¾ in. Hg in less than 1 min from the time of starting to open the valve. (The values of vacuums and differential pressures are instantaneous values at 3-min intervals and not averages for the 3-min periods, so Fig. 8 indicates the drop in vacuum as occurring in 3 min.) The pressure in the return at 6 min was 1½ lb per sq in. above atmospheric, indicating that the steam was materially assisting the pump in the removal of air. The 3 min peak of 2,630 cu ft per hour was reached in 6 min and was largely over in about 15 min. The air removed in the peak was about 510 cu ft, which is about one-half of that removed in the 30 min opening tests. The fact that the pressure in the returns (as well as in heating units) was above atmospheric pressure for about one-half of this peak period could hardly account for the escape of air through leaks to the extent of one-half the internal volume of the system. On another test under similar conditions, this air peak was 680 cu ft total. On a somewhat similar test at 11 a. m. on April 5 (see Fig. 3 upper left chart) the steam was turned into a warm system filled with air at atmospheric pressure with a resulting air removal peak of 400 cu ft. This test was made after the steam had been shut off for ½ hour and the return opened up to clean the pump strainer.

The condensate peak of 6,800 lb per hour in Fig. 8 was arrived at 15 to 21 min after cracking the valve, and was substantially over at 39 min. This peak was low because of the mild weather as shown by averages of an outside temperature of 49.5 F, sun effect of 382 cal per square centimeter and a wind velocity of 8.6 mph for this day and the day preceding. The lower chart in Fig. 3, which is for the period of this test, indicates less leakage into the system than at some other times as shown by the pump not running continuously during the time steam was shut off, as it did on several other similar occasions. After the air removal peak was reached, which was largely over in 12 min of operation, the pump operated entirely on float control until shortly after 2 hours of time had elapsed. During this period the vacuum steadily fell in spite of apparently less air leakage than on the other tests shown, due to the infrequent running to remove condensate and incidentally air. There were 17 starts of the pump in the 2-hour period. At 122 min of elapsed time the vacuum trip started the pump and an air removal peak with a rate of 1,300 cu ft per hour for a 3-min period occurred.

A summary of the conditions and results of the peak load tests shown in Figs. 6, 7 and 8 is given in Table 2. The ratio of the maximum condensate rate on the peak to the average rate after the peak was over and fairly normal conditions obtained was 2.56, 2.59 and 3.07. It would be expected that this ratio would be highest for the test with the most rapid opening of the valve, whereas it was not actually much higher. The maximum condensate rate depends not only on how rapidly steam is brought into the system but also on the temperature of the piping and heating units and their surroundings at that time. The weather was the warmest (49.5 F) on the test with the most rapid opening of the valve, which would make this peak ratio lower than expected.

The location of the condensation meters at the tunnel entrance, removed from the vacuum pump by 300 ft of 2 in. discharge pipe, introduces a lag in the condensation readings. This was found to be about 30 sec by measuring the interval from the starting of the pump to the arrival of water to operate the meters. This discharge pipe is carried on the ceiling of the heating and ventilating laboratory some 15 ft in elevation above the level

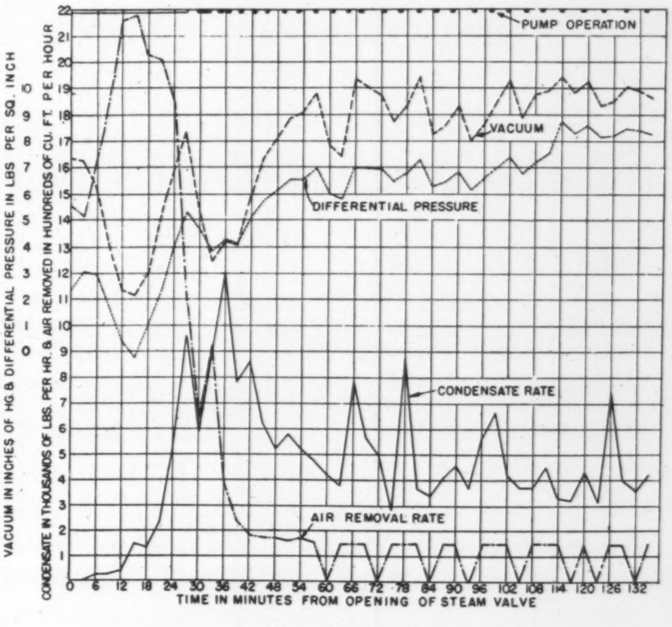

Fig. 7—Peak load test for March 8, 1936, with slow opening of steam valve

Table 2—Summary of Peak Load Test Results

Date		March 22	March 8	April 12
Data Shown in Fig.		6	7	8
Weather Conditions	Average Outside Temperature	42.5 F	32 F	49.5 F
	Average Wind Velocity, mph	9.5	7.5	8.6
	Sun Effect, Cal per Sq Cm	285	292	382
Approximate Time to Fully Open Valve, Minutes		30	30	4
Average Removal Rate for Normal Operation	Condensate, Lb per Hour	3630	4620	2215
	Air, Cu Ft per Hour	83.5	106.25	93
Time of Peak After Opening Valve, Minutes	Condensate	33	36	21
	Air	15	15	6
Removal Rate in Max. 3 min Peak	Condensate, Lb per Hour	9300	12000	6800
	Air, Cu Ft per Hour	1825	2175	2630
Ratio—Peak to Average	Condensate	2.56	2.59	3.07
	Air	21.8	20.48	28.3
Total Amount Removed During Peak Period	Condensate, Lb	4275	4310	2790
	Air, Cu Ft	897	1007	510
Total Pump Running Time for 2 Hour Period After Opening Valve, Hours		0.596	0.647	0.283
Pump Operation in Per cent of Time for 2 Hour Test		29.8	32.4	14.3

of the meter and, since the end of the line at the meter is equipped with an atmospheric vent, this pipe cannot act as a storage capacity. However, it discharges into a surge tank of 5,000 lb capacity located directly before the meters, from which tank the condensation enters them under low gravity head. Since the two meters in parallel have a combined capacity under these conditions of 24,000 lb per hour and the highest peak observed was 12,000 lb per hour for a 3-min period, it is considered that this is the true 3 min peak and that the lag in measuring condensation is of small consequence in the time relations of the air and condensation peaks. This lag likely accounts for some of the out-of-phase relation of condensation and air removal rates during near normal operation shown in Figs. 6, 7 and 8. The pump usually ran about 20 sec in any 3-min period and, when this occurred at the end of the period, the air would appear in that period and the condensation in the following 3-min period. No attempt was made to correct these minor differences.

A previous paper[2] reported to the Society indicates that the maximum load is encountered in a system at the time of maximum rate of condensation. The ratio of air to condensate at that time is therefore of importance and in those tests did not exceed 0.05 cu ft of air per pound of condensate when the system was operated at or above atmospheric pressure. In three tests under reduced pressures throughout the system this averaged 0.14 cu ft per pound.

In the present tests as reported in Figs. 6, 7 and 8 the returns were under approximately 8 in. vacuum at the start of the tests and a vacuum was maintained within the capacity of the pump under the peak load conditions. The vacuum extended into the supply mains up to the time of opening of the steam valve. The pressure in the supply main built up at a rate determined by the opening of the valve, rate of condensation and air elimination until finally it became stabilized under control of the reducing valve at about 3 lb per sq in. gage. For the test in Fig. 6 the supply line pressure was about 2 lb per sq in. gage at the time of maximum condensation. In this test the ratio of air to condensate at the peak is difficult to determine, due to the pump not running during the 3-min period previous to the peak. This places a larger removal load into the next 3-min period and makes the air and condensate loads at 33 min high. Using the values as plotted, this ratio would be 0.14 cu ft of air per pound of condensate. If the air removal values are averaged for the two periods ending at 30 and 33 min, this ratio would be 0.07. Should the peak at 42 min be considered the true condensation peak, the ratio would be 0.026, which is checked by the values of 0.033 from Fig. 7 and 0.028 from Fig. 8. In these latter tests there was no 3-min period in which the pump did not run. The supply main pressure was about 2 lb per sq in. gage at the time of the condensation peak for the test of Fig. 7, and only slightly above atmospheric for that of Fig. 8.

Summary

During normal operation of a vacuum heating system having a connected capacity of 38,782 sq ft of EDR with about 30,500 sq ft active, the condensate load was 2,614 lb per hour and the air removal load 87.6 cu ft per hour, which is a ratio of 0.034 cu ft of air per pound of condensate.

Under peak load conditions obtained by turning steam into the cold system, the ratio of air to condensate at the time of maximum condensate return was found to be 0.033 on a test with 30 min opening of the valve and 0.028 with 4 min opening of the valve. The difference in these values is not of any significance, and the ratio obtained depends to some extent on the conditions of operation and of testing.

In each peak load test the maximum air removal rate preceded the maximum condensate rate so that the two loads did not coincide. With the slower opening of the steam valve, the air peak occurred at 15 min and

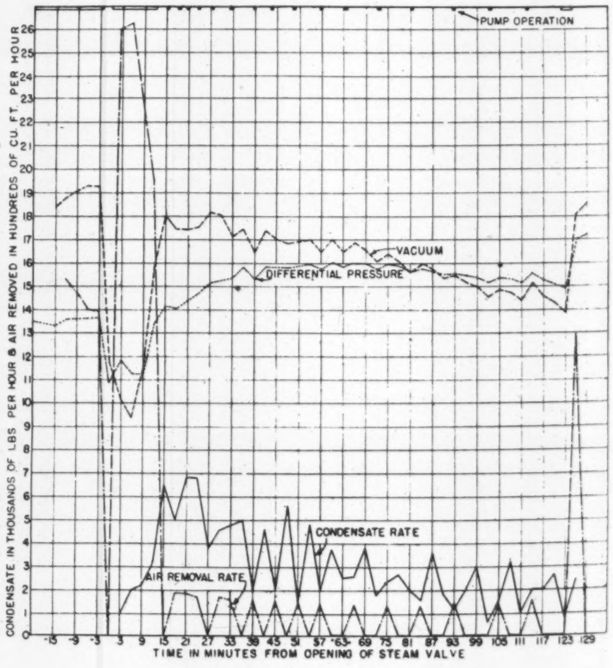

Fig. 8—Peak load test for April 12, 1936, with rapid opening of steam valve

the condensate peak at 33 to 36 min. The corresponding values for rapid opening of the steam valve were 6 and 21 min.

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[2] Condensate and Air Return in Steam Heating Systems, by F. C. Houghten and J. L. Blackshaw, A.S.H.V.E. Transactions, Vol. 39, 1933, p. 199.

The maximum condensate rate was slightly over 2.5 times the rate after normal conditions had been established for slow opening of the valve and about 3 times the normal rate for rapid opening of the valve. The corresponding ratios for air removal were about 21 and 28.

The vacuum pump used in these tests had a rated capacity of 90 gpm and 34 cfm at 10 in. vacuum and a capacity to serve 65,000 sq ft of radiation. During 8 days of normal operation with an outside temperature of 26.6 F, 5.8 per cent of the condensate capacity and 4.3 per cent of the air capacity were used. During peak load tests on a cold system the pump ran about 30 per cent of the first 2 hours with slow opening of the steam supply valve with an outside temperature of 42.5 F and 32.5 per cent of the time with an outside temperature of 32 F. With rapid opening of the valve and an outside temperature of 49.5 F, the pump ran 14 per cent of the time.

With slow opening of the valve and an outside temperature of 32 F, the maximum condensate measured in 3 min was at the rate of 12,000 lb per hour, which is about 27 per cent of the pump capacity on condensate. The air removal peak was 7 per cent over the rated air handling capacity. With rapid opening of the valve and an outside temperature of 49.5 F, the maximum condensate rate in 3 min was 6,800 lb per hour, which is about 15 per cent of the condensate handling capacity. The air removal peak in this test was 30 per cent over the rated air capacity due to the building up of a positive pressure in the return piping. At no time during the peak load tests did the pump run under float control to remove condensate as long as 1 min in any 3-min period.

Had such tests been made in the coldest weather, the above condensate peaks would have been greatly exceeded. In these tests slow opening of the valve corresponded to a 30-min period and rapid to a 4-min period from closed to fully open. There seems little reason for a period as short as the latter in the operation of a large heating system. The air peaks obtained depend upon the rate of entrance of steam to the system and the capacity of the pump to remove the air. A limited capacity on starting from cold conditions is perhaps desirable in order to reduce the strains due to heating up of piping and radiation.

Acknowledgments

The results presented in this paper were obtained in the Department of Mechanical Engineering of which G. L. Larson is Chairman and Professor of Steam and Gas Engineering. Acknowledgment is also due to J. A. Dickie for the material collected in 1934-35 for his Master's Thesis, with G. Androne and R. A. Wilson assisting. The following assisted on the project during 1935-36: G. R. Anderson, A. J. Beyer, M. B. Conrad, L. W. Griffith, B. M. Kluge, C. L. Sawyer, R. A. Sharp and E. L. Wefel.

Vocational Clinic for Embryo Engineers

Five out of six Washington high school graduates picked by their respective principals as the leaders in the graduating class of 1936 stated to a recent audience of the Rotary Club of Washington that they expected to be engineers, according to the *American Engineering Council's* news letter. One had chosen civil engineering, two mechanical, one electrical and one management engineering. Each was an outstanding personality and they gave a better account of themselves than perhaps most of their listeners could have done. Dr. Mann, Secretary Emeritus of the *American Council of Education,* has suggested that the professional men in each city could well organize a Vocational Clinic, and offer to young men and their parents the chance to learn the training and opportunities for each profession.

The *Associated Technical Societies* of Detroit recently held its first annual guidance meeting at which 123 boys and their parents were given an opportunity to consult representatives of various branches of the engineering profession. The conference was an outgrowth of the activities of the Committee on Student Selection and Guidance of the *Engineers' Council for Professional Development,* and was typical of guidance meetings which *E.C.P.D.* is promoting in other areas through local associations of engineers.

Local engineering groups in other parts of the country desirous of undertaking a guidance project can get further details on the Detroit meeting from Dean C. J. Fruend, University of Detroit. General instructions and assistance should be obtained from Dean R. L. Sackett, Pennsylvania State College, State College, Pa., who is chairman of the Committee on Student Selection and Guidance of *E.C.P.D.*

Effect of Humidity on Heated Wire in Air Stream

The possibility of a humidity effect on the heat loss from a heated wire in an air stream has long been recognized, but only recently was the effect found experimentally by Paeschke. The effect is to increase the heat loss at the higher humidities.

In a National Bureau of Standards Research Paper RP850, entitled Effect of Humidity in Hot-Wire Anemometry, by G. B. Schubauer, an experiment was conducted to verify the existence of the humidity effect. The results show an increase of heat loss per degree rise in wire temperature of about 2 per cent for a change in the partial pressure of water vapor from 0.007 to 0.023, or a change in relative humidity from 25 to 70 per cent in the neighborhood of 25 C. The effect may be explained by an effect of humidity on the thermal conductivity of air.

Independent Dehumidification

By L. S. Ourusoff *, (*MEMBER*) Washington, D. C.

THIS paper relates to the description of the installation of an adsorption dehumidifying comfort system in the office building of the Washington Gas Light Co. in Washington, D. C. In 1934 prior to the selection of this system, a tentative analysis of various methods of air conditioning was made, which are summarized in Table 1.

System Design

The method of air conditioning was selected after considering the available combinations of: dehumidifiers with city water or cooling tower, dehumidifiers with well water, dehumidifiers with compression using city water or cooling tower, and pure compression with city water or cooling tower.

The first method could not be utilized with the prevailing summer city water and atmospheric wet-bulb temperatures (around 85 F and 79 F respectively), and as of the remaining three solutions, the last two were estimated as costlier to install and to operate, final selection was made of the dehumidifier and well water combination.

The types of system designs considered were outside air dehumidifiers with recirculating central coolers, partly recirculating dehumidifiers with recirculating central coolers, and outside air or recirculating dehumidifiers with individual room coolers.

The first type was selected because it appeared as the least expensive to install and also offered a compromise between the desired volume of outside ventilating air and the required volume of dry air supply for maximum comfort. The second type would have involved additional duct work installation difficulties in the limited basement space available and the third type required excessive first and maintenance costs.

General Description

The general schematic layout of the installation shown in Fig. 1, consists of a duplex central system with an individual dehumidifier, dry air cooler and main cooler for the north and south portion of the building. Outside air is drawn through the dehumidifiers, precooled in the dry air coolers and thence mixed with recirculated air, before entering filters and main coolers, from which the dry, cool and clean air is delivered to the offices.

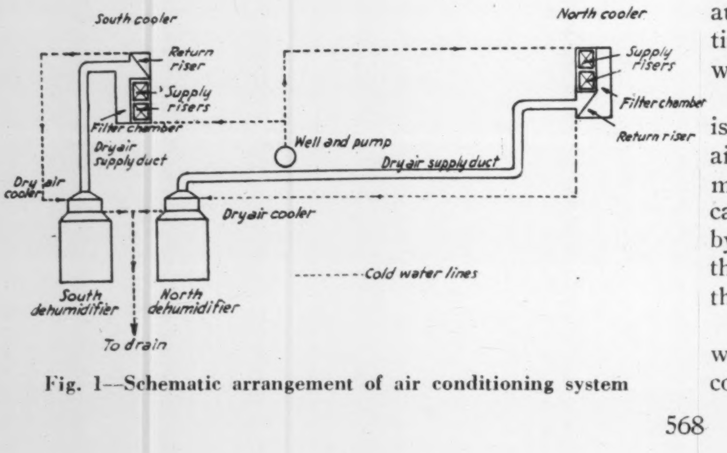

Fig. 1—Schematic arrangement of air conditioning system

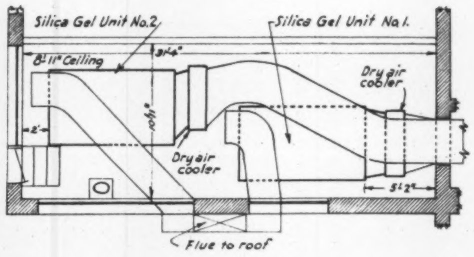

Fig. 2—Plan drawing of equipment in dehumidifier room

Water at 63 F is supplied by the well pump, directly to each of the main coolers, from which it leaves at from 68 to 75 F (depending on the flow and load), and thence proceeds to the dry air coolers, where it is reutilized by extracting sensible heat from the high temperature dry air. The water finally leaves the dry air coolers at from 80 to 100 F (depending on flow and load) and passes to the sewer.

The dehumidifiers are controlled independently from the rest of the system. This method of control allows a selection of conditions for any desired effective temperature. The use of well water eliminates the necessity of having compensating controls to reduce shock. When once the flow of water is properly adjusted, the inside temperature varies with the outside temperature so as to approach a point midway between 70 F and the outside temperature.

Dehumidifiers

Two gas fired silica gel dehumidifiers capable of producing approximately 13 tons of latent heat removal each, and rated at 3500 cfm per unit, are located, together with the dry air coolers, in a room 31 x 11 x 9 ft, as shown in Fig 2. Whenever the humidistats are satisfied the machines stop, and the outside air louvers open automatically in the dry air cooler duct, in order to continue an uninterrupted supply of outside ventilating air, without further dehumidification.

A schematic drawing of the type of dehumidifiers used is illustrated in Fig. 3. In operation the wet outside air is forced by adsorption fan F_2 into drying compartment *B* where four horizontal beds of silica gel are located. The air is properly directed through the beds by baffles which insure uniform air distribution over the beds. Dry air is then supplied to distribution ducts through outlet *S*.

While this action is taking place a similar, but downward process of activation is occurring in the opposite compartment *A*. Hot activation air from the combustion chamber is sucked by activation fan F_1 through open valve V_1 and passes diagonally downward through open valve V_2 to fan F_1, and activation outlet *X* from which it is discharged to the atmosphere. While in compartment *A,* the hot air sweeps the gel beds contained therein and removes the moisture which had been adsorbed by the gel in a previous cycle, when compartment *A* acted as compartment *B*. The activation and adsorption processes continuously take place in opposite compartments and this continuity is made possible by motor operated, automatically timed valves, which change position when a cycle is completed, allowing a new cycle to start in opposite compartments. The adsorption process lasts 10 min as does the activation process, but the last 3 min of the latter may be termed *purging* because the gas supply is automatically cut off at the beginning of the last 3 min, and the activation air thereafter cools and purges the gel rather than drys it. This is necessary to prepare the gel for the next cycle of adsorption which cannot proceed efficiently at a high temperature.

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*Engineer of Utilization, Washington Gas Light Co.

The machines have a thermal efficiency of 40 per cent (ratio of latent heat removal to activation heat input) and possess a dehumidifying efficiency of 60 to 70 per cent depending on the absolute humidity of the incoming air, with higher efficiency corresponding to lower humidity. The dehumidifying capacity, however, increases directly as the absolute humidity of the entering air.

The temperature of the dry air leaving the machine averages 150 F during each cycle and the temperature of the activation exhaust air averages 135 F. The high temperature of the dry air is due to the transformation of latent into sensible heat, to some residual heat left in the silica gel beds by the activation air, and to a slight heat transmission from the activation air to the dry air.

Well

The well, as illustrated in Fig. 4, has a capacity of from 125 to 175 gpm, varying seasonably. It is 47 ft deep and has a 10 in. diameter casing. The pump is a five stage, water lubricated, turbine type, with a 5 hp motor, selected with a capacity in excess of requirements with a view towards future additions to conditioned spaces.

Main Coolers

The main coolers consist of two sound-proofed finned coil, floor type coolers. Each unit is rated at 12,000 cfm and capable of producing 15 tons of refrigeration when supplied with 50 gpm of 63 F water at 83 F inlet air.

Table 1—Record of 1934 Survey of Existing and Potential Possibilities for Various Energies when Applied to Air Conditioning

	METHOD	ENERGY	EXISTING POSSIBILITIES	REASONS	POTENTIAL POSSIBILITIES	REASONS	REMARKS
1	Compression Refrigeration	Electricity	Good	Commercially developed, growing demand, downward costs	Good	Growing demand	More competition from other methods in future possibility for heating
		Gas	Poor except for industrial application with natural gas	High fixed charges and insufficiently refined equipment to date	Fair when further developed	Downward trend in cost of summer energy—Active research	Available waste energy and possibilities for heating
		Oil	Fair for large applications when electric cost high	High electric costs may justify central Diesel generating plants	Questionable	Downward trend in cost of more refined forms of energy	
		Steam	Poor	Low efficiency, high fixed charges and maintenance	Poor	Low efficiency, high fixed charges and maintenance	
2	Absorption Refrigeration	Electricity	Poor	Low efficiency compared with compression	Poor	Low efficiency compared with compression	
		Gas	Poor	Undeveloped equipment and low efficiency	Fair	Downward trend in cost of summer energy—Active research	Can use waste heat from gas engine in conjunction with No. 1
		Oil and Coal	Poor	Not developed	Questionable	Downward trend in cost of more refined forms of energy	
		Steam	Poor	Not developed	Fair where district or exhaust steam available		
3	Dehumidifying by Adsorption or Absorption	Electricity	Poor	Not developed—Costly operation	Poor	Costly operation	
		Gas	Questionable	Insufficientlydeveloped equipment	Good	Flexible method, active development, downward trend in cost of summer energy	Can be used in combination with No. 1, 2,and 6
		Oil and Coal	Questionable	Insufficientlydeveloped equipment	Questionable	Downward trend in cost of more refined forms of energy	
		Steam	Questionable	Insufficientlydeveloped equipment	Fair	Waste steam may be available	
4	Steam Jet Refrigeration	Electricity	Poor	Low efficiency	Poor	Low efficiency	
		Gas	Poor	Low efficiency	Poor	Low efficiency	
		Oil and Natural Gas	Questionable	Possible where other energies costly	Questionable	Possible where other energies costly	
		Steam and Soft Coal	Fair	Simplicity	Fair	Simplicity	Where low cost district or waste steam or soft coal available
5	Direct Ice Refrigeration		Fair where other energy is costly	Low fixed charges	Questionable	High operating cost, downward trend in cost of other energies	
6	Direct Water Refrigeration		Good where sufficient cold water available at reasonable cost	Simple — Low fixed charges—economical	Good where sufficient cold water available at reasonable cost	Simple—Low fixed charges—Economical	Water may be economical for preheating ventilating air in Winter

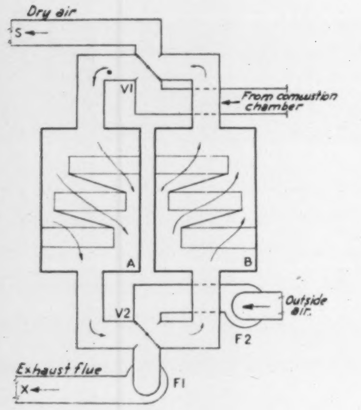

Dry air
S
VI
From combustion chamber
A
B
V2
Outside air
F2
Exhaust flue
X
F1

Fig. 3—Schematic drawing of dehumidifier installed

Dry Air Coolers

The dry air coolers consist of two sets of finned coils, each capable of reducing dry air temperature from an average of 150 F to an average of 75 F when supplied with 50 gpm of 71 F waste water from the main coolers.

Filters

The filters used are of the throw-away type made up of oil covered steel wool. They are located in chambers at the inlet of the main coolers where they clean both the outside and recirculated air.

Indoor Conditions

With outside design conditions of 95 F dry-bulb, 78 F wet-bulb, 46 per cent relative humidity, 117 grains per pound—the system was capable of maintaining a choice of indoor conditions ranging from 75 F dry-bulb, 55 per cent relative humidity to 85 F dry-bulb, 40 per cent relative humidity, corresponding to a selective range of from 70.5 to 76.5 deg effective temperatures.

Capacity

The required capacity for the outside design conditions previously stated and the inside conditions at 85 F dry-bulb, 67.5 F wet-bulb was computed to be 54 tons for 180,000 cu ft of conditioned space and 170 people, allocated as: sensible heat by main coolers, 21.7 tons; useful sensible heat by dry air coolers, 6.3 tons (total sensible heat, 52 per cent); and latent heat by dehumidifiers, 26.0 tons (total latent heat 48 per cent). The sensible heat computation was further divided to 21 tons from air temperature and sun, and 7 tons from people and lights.

The actual equipment capacity was 68 tons, allocated as: sensible heat by main coolers, 30 tons; useful sensible heat by dry air coolers, 12 tons (total sensible heat 62 per cent); and latent heat by dehumidifiers, 26 tons (total latent heat 38 per cent).

The sensible heat equipment was selected 50 per cent oversized in order to allow for lower inside temperatures, if desired, and to provide for future additional conditioned spaces. Although in *design weather* the latent heat capacity is somewhat smaller than the sensible heat tonnage, it should be noted that on the average day this balance is not maintained. An outside temperature of 95 F dry-bulb is seldom sustained, whereas extreme humidities in the neighborhood or in excess of 117 grains per pound frequently occur in Washington.

Connected Load and Load Factors

Electricity

The total electric connected load is 17.5 kw as recorded by demand meter, and is carried by two 5-hp motors on cooler fans, one 5-hp motor on well pump, two 3-hp motors on dehumidifier fans, and two 1/8-hp motors on dehumidifier valves, giving a total of 21¼ hp. This electric load is apportioned as 47 per cent ventilation, 23.5 per cent cooling, and 29.5 per cent dehumidifying.

The unit electric connected load is 0.26 kw per ton of

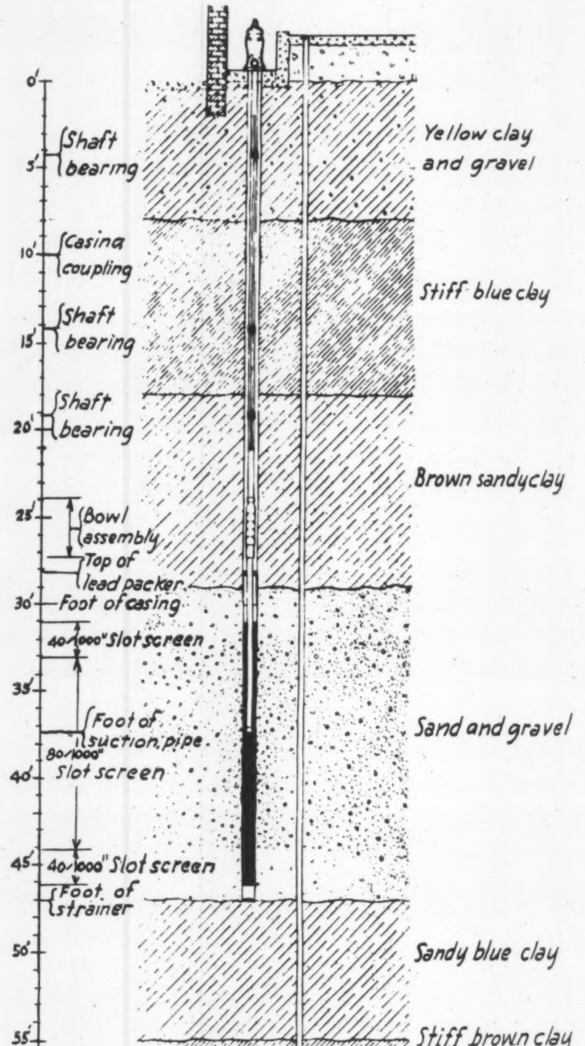

0'
5'
10'
15'
20'
25'
30'
35'
40'
45'
50'
55'
60'
65'
70'
75'
Shaft bearing
Casing coupling
Shaft bearing
Shaft bearing
Bowl assembly
Top of lead packer
Foot of casing
40/1000" Slot screen
Foot of suction pipe
80/1000" Slot screen
40/1000" Slot screen
Foot of strainer
Yellow clay and gravel
Stiff blue clay
Brown sandy clay
Sand and gravel
Sandy blue clay
Stiff brown clay
Sand
Heavy blue clay and shale
Sand and gravel
Stiff black clay

Fig. 4—Cross section of soil showing deep well pump location

available refrigerating capacity. If the equipment capacity had not been over-sized the total connected load would have been 12.5 kw consisting of two 3-hp motors on cooler fans, one 3-hp motor on well pump, two 3-hp motors on dehumidifier fans, and two ⅛-hp motors on dehumidifier valves for a total of 15¼ hp, apportioned as 39.0 per cent ventilation, 20.0 per cent cooling, and 41 per cent dehumidifying, equivalent to 0.23 kw per ton of refrigerating capacity. The daily load factor from July 22 to September 15 was actually 43 per cent but should have been normally 64 per cent, except that on two occasions the equipment was deliberately operated at night, which increased the maximum day from 200 kwhr to 302 kwhr. The hourly load factor for the same period (excepting a few hours of overload at the beginning of the period which raised the hourly demand from 17.5 kw to 18 kw) was 31 per cent. These factors follow daily cooler operation from 6:30 a. m. to 6:30 p. m. and dehumidifier operation from 8:00 a. m. to 5:15 p. m., excepting Saturdays when operation was from 6:30 a. m. to 1:00 p. m. and 8:00 a. m. to 1:00 p. m. respectively, with no operation on Sundays or holidays.

Gas

The connected load is 1250 cu ft per hour of 600 Btu per cu ft gas, or 750,000 Btu per hour, and is equal to 70 per cent of the connected load necessary for winter gas heating of the corresponding spaces.

The daily load factor for the period from July 22 to September 15 was 46 per cent and the hourly load factor was approximately 20 per cent, compared with respective factors for the heating season of 36 per cent and 21 per cent.

All of the summer load factors for electricity and gas, having been based on operation during about half a summer season, including normal proportions of hot and cool days, should approximate factors applicable to the entire summer season.

Energy Consumption

For the period July 22 to September 15 the energy consumption was: electricity, 7094 kwhr; gas, 321,000 cu ft; and well water, 0.75 gpm per ton.

It should be noted that the electric consumption was higher than normal, due to over-sized cooling equipment and normally would have been reduced by the difference between the available and required sensible connected load, multiplied by its hours of operation, namely 5,000 kwhr. Estimating the actual period of operation as half of a normal season, and correcting for over-sized electric equipment, the normal seasonal energy consumption should be: electricity, 10,000 kwhr; gas, 642,000 cu ft; and well water, 0.75 gpm per ton.

The winter gas consumption for the equivalent space would be approximately 1,900,000 cu ft. It is estimated that the dehumidifiers, operated in conjunction with compressors using well water for condensing would have consumed during the summer season: electricity, 17,000 kwhr; and gas, 642,000 cu ft.

Represented in Fig. 5 is an interesting illustration of variations of actual gas and electric consumptions through August. It will be noted that the gas consumption curve has followed the outside average dew point temperature curve almost coincidently. The electric consumption curve follows the same trend but less markedly because of the high electric load factor resulting mostly from constant ventilation which is independent from the dew point temperature. The outside dry-bulb temperature curve follows the other curves irregularly, this occurring because the entire gas load and the majority of the electric load are used for dehumidification and ventilation, both of which may be independent of the dry-bulb temperature.

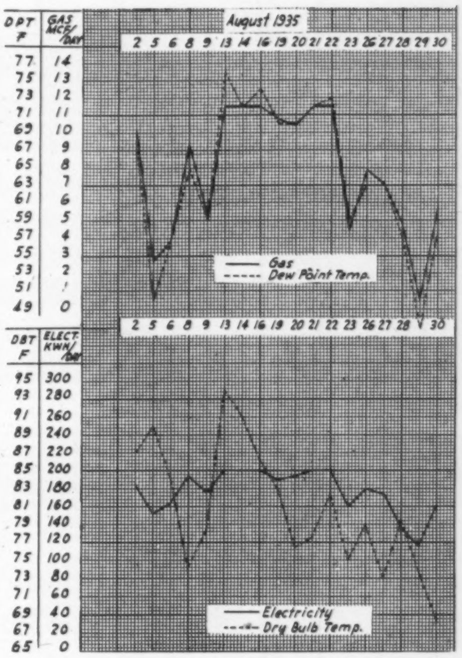


Fig. 5—Daily gas and electricity consumptions plotted with dew point and dry-bulb temperatures for August 1935

The close relationship between gas consumption and outside dew point temperature is quite significant in that it will, in future, permit accurate estimates of seasonal gas consumption for similar installations under different climatic conditions.

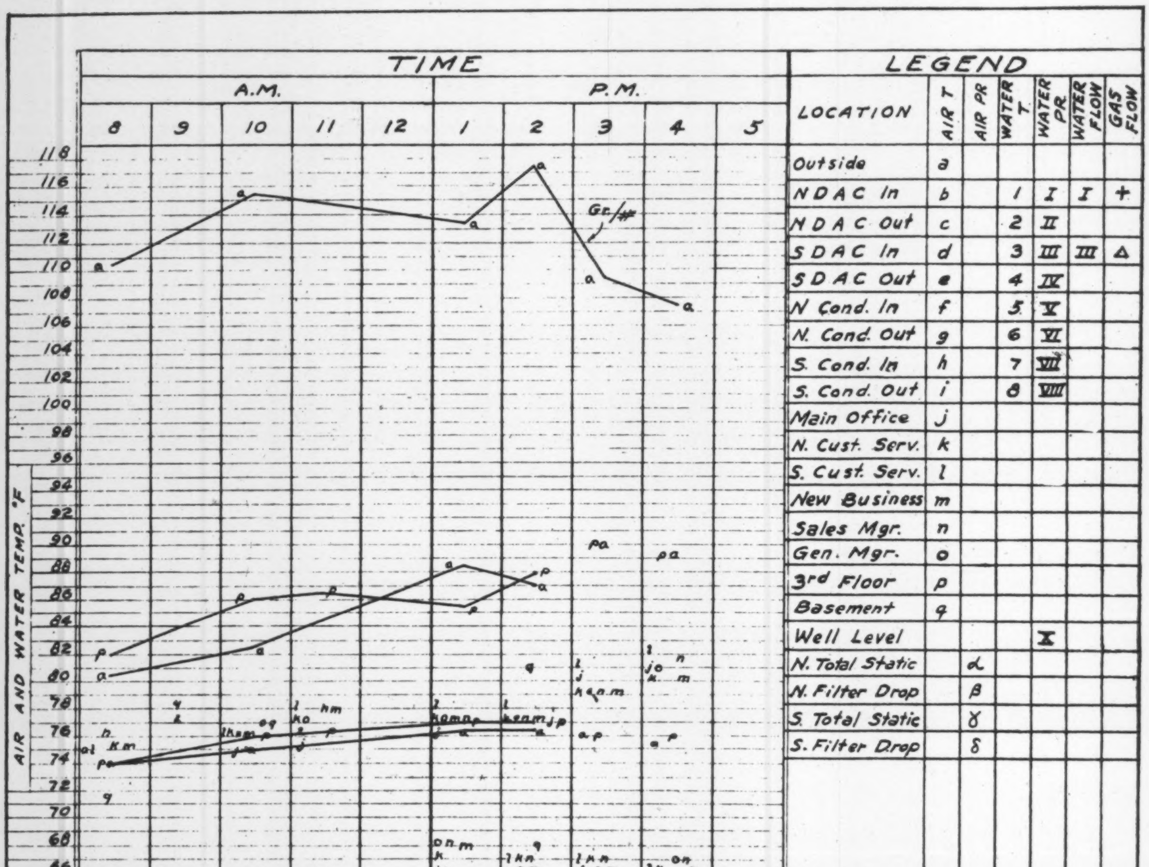
Operating Costs

Unit costs of energy are assumed as: $0.02 kwhr for electricity, $0.40 per 1,000 cu ft for summer gas, and $0.62 per 1,000 cu ft for winter gas (electric and gas rates as charged in this particular installation).

Applying these unit costs to the amounts of energy consumption, the following operating costs may be obtained:

1. Actual cost of energy for approximately half a season and with oversized equipment was: electricity, $142.00 or 52 per cent, and gas $129.00 or 48 per cent for a total of $271.00.
2. Cost of energy for the same installation for entire summer season and required equipment only would be: electricity, $200.00 or 44 per cent, and gas, $258.00 or 56 per cent for a total of $458.00.
3. Cost of heating the same space during 7 winter months with gas is $1,180.00.
4. Cost of energy for entire summer with dehumidifiers operating in conjunction with compression, using well water for condensing would be: electricity, $340.00 or 57 per cent, and gas, $258.00 or 43 per cent for a total of $598.00.

Depreciation and maintenance costs were not analyzed because one summer's performance cannot yield sufficient



LEGEND

LOCATION	AIR T	AIR PR	WATER T	WATER PR	WATER FLOW	GAS FLOW
Outside	a					
NDAC In	b		1	I	I	+
NDAC Out	c		2	II		
SDAC In	d		3	III	III	△
SDAC Out	e		4	IV		
N Cond. In	f		5	V		
N. Cond. Out	g		6	VI		
S. Cond. In	h		7	VII		
S. Cond. Out	i		8	VIII		
Main Office	j					
N. Cust. Serv.	k					
S. Cust. Serv.	l					
New Business	m					
Sales Mgr.	n					
Gen. Mgr.	o					
3rd Floor	p					
Basement	q					
Well Level				X		
N. Total Static		α				
N. Filter Drop		β				
S. Total Static		γ				
S. Filter Drop		δ				

Dry Bulb T - Blue Gas Flow - Blue
Wet Bulb T. - Red Gr/# - Green
Water Pr. - Blue
Water Flow - Red

WATER FLOW G.P.M.	GAS CU. FT. 1 HR	AIR PRESSURE Inches H2O
120	600	2.0
115	575	1.9
110	550	1.8
105	525	1.7
100	500	1.6
95	475	1.5
90	450	1.4
85	425	1.3
80	400	1.2
75	375	1.1
70	350	1.0
65	325	.9
60	300	.8
55	275	.7
50	250	.6
45	225	.5
40	200	.4
35	175	.3
30	150	.2
25	125	.1
20	100	0
15	75	
10	50	
5	25	
0	0	

Shower from 1:00 to 1:10, Outside temp. taken before shower — Inside after *1 Sillica Gel found off at 1:06. Unknown party had reset humidistat.

COMMENTS & REMARKS INCLUDE
General weather, occupancy, adjustments, breakdowns, oiling, fuses, total hours operation, comfort, sand, noise etc.

Water 1st. Readings
Electr. " 3636
Gas " 72400 75200

COMMENTS- System on at 5:30 am.
Total static head measured at filter outlet.
System on approx. 2 hrs in evening - Testing.

Observer: L. Burt
Date: 7-22-35

Fig. 6—Air conditioning log sheet for July 22, 1935

information. There are indications, however, that these important items of cost are probably higher for the conventional compression installation than for a combination system using dehumidifiers.

Initial Cost

The complete installation has necessitated an expenditure of $235.00 per ton of available capacity and of $300.00 per ton of required capacity.

Estimates for a combination system of dehumidifiers and compressors and for a pure compression system have indicated that either could be installed for between $300.00 and $350.00 per ton, depending upon the quality and refinement.

The allocation of costs for this system is approximately:

Dehumidifiers installed	33 per cent
Cooling units	18 per cent
Air distribution system	18 per cent
Well and pump	11 per cent
Plumbing and wiring	7 per cent
Dry air coolers	5 per cent
Controls	3 per cent
Filters	1 per cent
Miscellaneous	4 per cent
	100 per cent

Performance

Operation of the system has required little maintenance or attention. Regular lubrication of the pump and fans represented practically all of the maintenance. The system has proven exceedingly flexible from a control standpoint, and the available independent control of humidity has permitted the maintenance of effective temperatures between 69 and 73 deg under varying outside conditions, without experiencing the sensation of chill.

The average daily dry-bulb inside to outside differential was maintained low in moderate weather and limited to 12 F in extreme weather, with the exception of one day.

Hourly readings and observations of inside and outside conditions and other factors were taken on a special log, a typical example of which is Fig. 6. This form offers the advantage of clearly indicating at a glance the trend of daily changes outside, and in a number of different spaces inside.

A reproduction of six temperature and humidity recording charts, taken on typical July and August days is given in Fig. 7. These charts cover a variety of atmospheric and inside conditions and illustrate the flexibility attained by independent humidity control.

The continuous lines on these charts are actual records obtained in the main display room whereas the dotted lines, representing outside conditions, were derived from readings and added. The outside relative humidity lines represent humidities adjusted to the inside dry-bulb temperatures.

The conditions recorded on Fig. 7 may be supple-

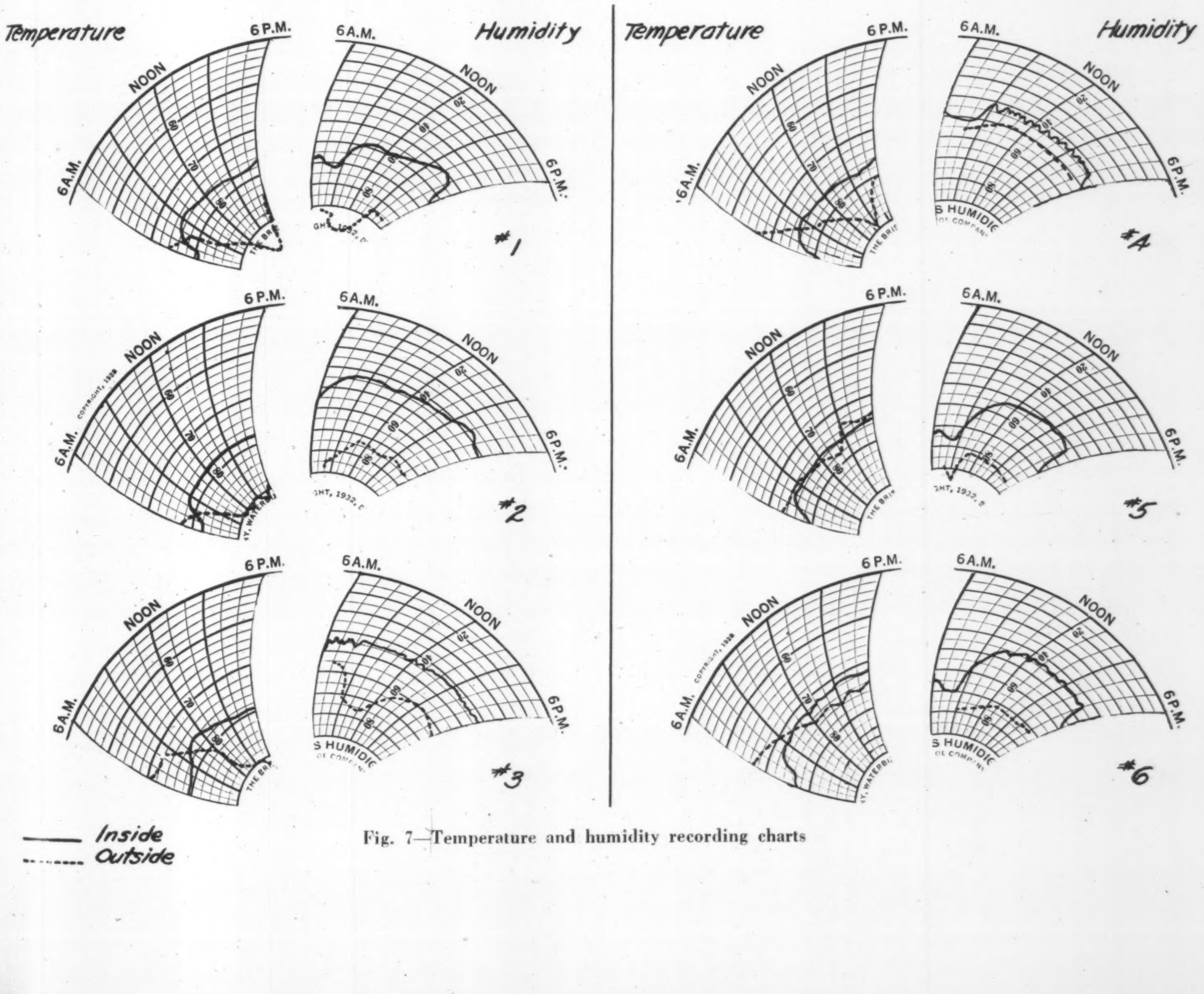


Fig. 7—Temperature and humidity recording charts

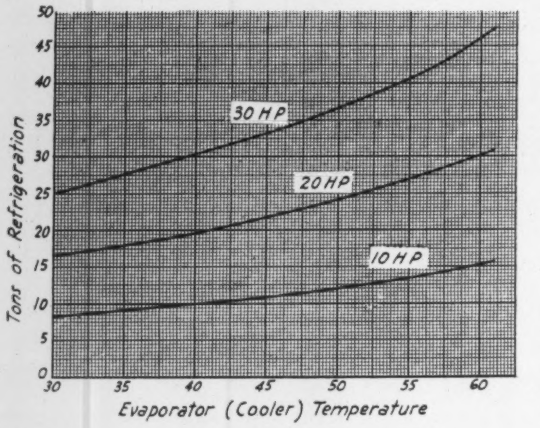


Fig. 8—Capacity curves for typical dichlorodifluoromethane compressors based on 76 F cooling water

mented by comments:

1. Exceptionally hot and humid day, exceeding *design weather.* Maximum absolute humidity 140 grains per pound, corresponding to 80 F wet-bulb at design dry-bulb temperature. Dew point temperature 77 F, so that if cooling alone had been performed, rain would have fallen inside the building below 77 F dry-bulb temperature. Maximum actual outside dry-bulb temperature 98 F. Average effective temperature: 84 deg outside and 73 deg inside.
2. Very hot and damp sunny day, maximum absolute moisture 123 grains per pound, corresponding to 79 F wet-bulb at design dry-bulb temperature. Maximum actual dry-bulb temperature 92 F. Average effective temperature: 82 deg outside and 72 deg inside.
3. Typical hot and damp day, cloudy and slight rain in the morning; sunny in the afternoon. Maximum absolute moisture 107 grains per pound, corresponding to 77 F wet-bulb at design dry-bulb temperature. Maximum actual dry-bulb temperature 93 F. Average effective temperature: 77 deg outside and 71 deg inside.
4. Warm, dry, mostly sunny day. Maximum absolute moisture 73 grains per pound, corresponding to 71 F wet-bulb at design dry-bulb temperature. Maximum actual dry-bulb temperature 89 F. Average effective temperature: 76 deg outside and 71 deg inside.
5. Cool and damp, rainy day. Maximum absolute moisture 124 grains per pound, corresponding to 79 F wet-bulb at design dry-bulb temperature. Maximum actual dry-bulb temperature 78 F. Average effective temperature: 75 deg outside and 71 deg inside.
6. Cool and moderately damp, cloudy day. Maximum absolute moisture 97 grains per pound, corresponding to 76 F wet-bulb at design dry-bulb temperature. Maximum actual dry-bulb temperature 76 F. Average effective temperature: 72 deg outside and 69 deg inside.

Characteristic of this installation was the feeling of dryness and freshness, doubtlessly caused by ample ventilation, combined with adequately proportioned dehumidification and cooling. The absence of smoke in the atmosphere, even during crowded office meetings, can be attributed to the liberal outside air supply.

Winter Conditioning

This system has been converted to year-round conditioning, so that existing facilities can be utilized to produce satisfactory effective temperatures in winter as well as summer. This is achieved by using the present ducts, cooler and well system with the addition of a small boiler. Ample outside air is supplied, mixed with a limited volume of recirculated air, filtered, preheated to 60 F by well water in the major portion of the existing cooling coils, then reheated to 72 F by steam in the remaining coils and finally supplied with controlled steam for proper humidification, prior to delivery to the offices.

It is interesting that direct well water air heating is particularly economical in cold weather, and the controls are designed to shut off the well when the outside temperature reaches 50 F. The steam coils are supplied at a constant rate of input, independently of outside temperature up to 65 F, when the fuel is automatically cut off. The above description refers to ventilation, humidification and filtering only, the bulk of space heating being still contributed by radiators.

Discussion

In this particular system the independence of humidity removal from cooling is in itself a feature containing at least two advantages. The system lends itself to modern methods of differential control. It affords a selection of conditions within the comfort zone, so advantageous because individual ideas of comfort may be satisfied, and because inside conditions may be made to function with fluctuating outside conditions or with other load variations, such as the number of people in the building. There is also the economic advantage of operating only the appropriate component of the equipment at a time, so that it becomes unnecessary to run the entire plant, when only humidity or only sensible heat are to be removed. Obviously this means a substantial energy saving as well as decreased wear. These two features, or rather their combination, seem to afford a solution difficult to obtain through other means, for if a pure compression system can be made more flexible than is usual, by means of controlled reheating or through independent compressors for latent and sensible heat removal, then the cost of its operation and installation will probably increase instead of decrease.

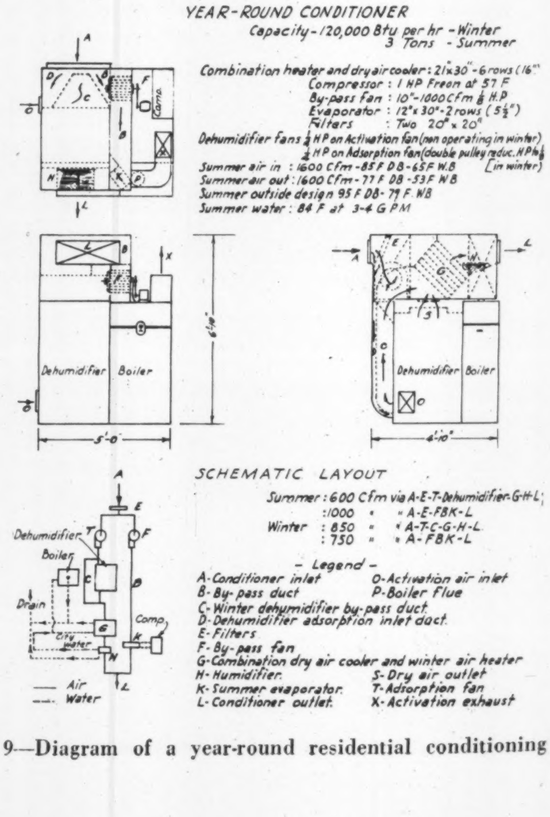

YEAR-ROUND CONDITIONER
Capacity - 120,000 Btu per hr - Winter
3 Tons - Summer
Combination heater and dry air cooler: 21x30" - 6 rows (16"
Compressor: 1 HP Freon at 57 F
By-pass fan: 10"-1000 Cfm 1/8 H.P
Evaporator: 12"x30"-2 rows (5½")
Filters: Two 20"x20"
Dehumidifier fans ½ HP on Activation fan (non operating in winter)
¼ HP on Adsorption fan (double pulley reduc. HP to 1/8 [in winter)
Summer air in: 1600 Cfm - 85 F DB - 65 F W.B
Summer air out: 1600 Cfm - 77 F DB - 53 F WB
Summer outside design 95 F DB - 79 F WB
Summer water: 84 F at 3-4 GPM
A
C
D
F
S
P
H
L
Comp.
X
6'-10"
Dehumidifier
Boiler
5'-0"
A
E
G
H
S
L
O
4'-10"
SCHEMATIC LAYOUT
Summer: 600 Cfm via A-E-T-Dehumidifier-G-H-L;
: 1000 " " A-E-FBK-L
Winter: 850 " " A-T-C-G-H-L
: 750 " " A-FBK-L
- Legend -
A-Conditioner inlet
B-By-pass duct
C-Winter dehumidifier by-pass duct
D-Dehumidifier adsorption inlet duct
E-Filters
F-By-pass fan
G-Combination dry air cooler and winter air heater
H-Humidifier
K-Summer evaporator
L-Conditioner outlet
O-Activation air inlet
P-Boiler flue
S-Dry air outlet
T-Adsorption fan
X-Activation exhaust
A
E
T
F
Dehumidifier
Boiler
C
B
Drain
G
City water
Comp.
K
H
L
Air
Water

Fig. 9—Diagram of a year-round residential conditioning unit

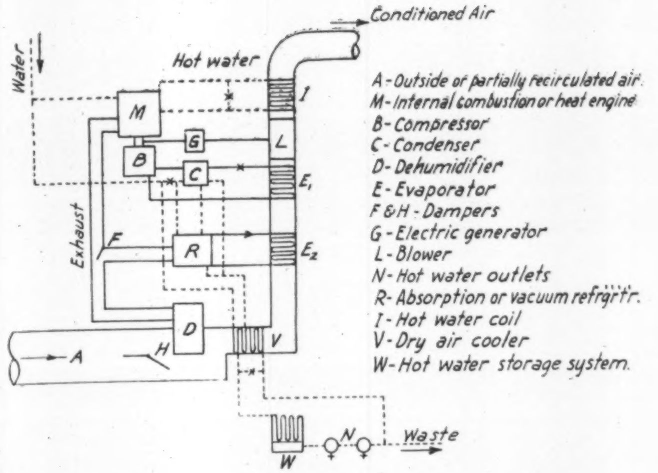


Fig. 10—Air conditioning system utilizing waste energy from internal combustion engine

Low maintenance and depreciation follows from the absence in the dehumidifying equipment of reciprocating or high speed centrifugal moving parts; from the durability of the adsorption material, and from the reduced hours of necessary operation for each component of the equipment.

The possibility of utilizing an inexpensive, but easily controllable and continuously available form of energy during the summer months is a third feature.

A fourth feature is the possibility of using high temperature refrigerants (60 F or higher), such as water which may be low in cost or a compressor operating at high evaporator temperatures. Some typical horsepower curves in relation to compressor capacity versus evaporator temperature, which illustrate the principle of economy at high evaporator temperatures, are given in Fig. 8.

The ability of the dehumidifier to become also a refrigerator, when operated by evaporative cooling of the dry air, is another feature which may under certain circumstances prove beneficial. The dehumidifier may also be used as a heater, supplying dry air, offering a valuable and unique method of winter conditioning for damp climates, such as that of Florida.

A seventh feature is the availability of the dehumidifiers for combined heating and drying for process application.

The dehumidifiers may be adapted to supply hot water free of cost, as a by-product of the sensible heat in the dry air by connecting the first coils of the dry air cooler to a storage tank.

A final point which makes the discussion of this system of interest is the present availability of this equipment at reasonable costs and at operating costs comparing favorably with other types of equipment It is noteworthy that some of these dehumidifiers are available for residential as well as commercial use and units are fabricated for capacities as low as two tons.

A year-round residential conditioning unit is shown in Fig. 9. This proposed equipment is characterized by compactness, and by the method of construction, consisting of an assembly of standard components. The unit requires no more floor space or ceiling height than a conventional warm air furnace of equivalent capacity. The assembly consists of a dehumidifier, compressor, humidifier, boiler, coils and fans assembled so that appropriate groups of component equipment are arranged together for winter or for summer operation. The winter output of the unit is 120,000 Btu per hour and the summer capacity approximately 3 tons of refrigeration. The summer operating cost in Washington, D. C., is estimated near $90.00 for four months and the relation of latent to sensible capacity is such that low humidity and relatively high temperatures may be maintained in extreme weather.

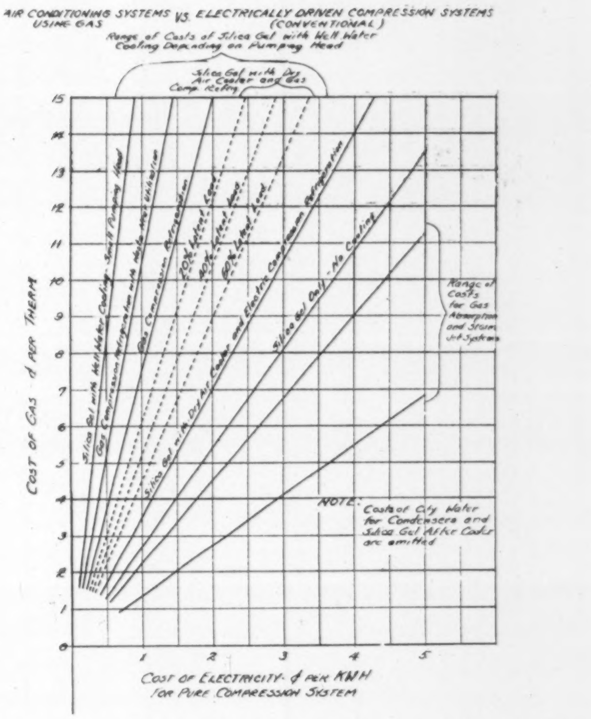


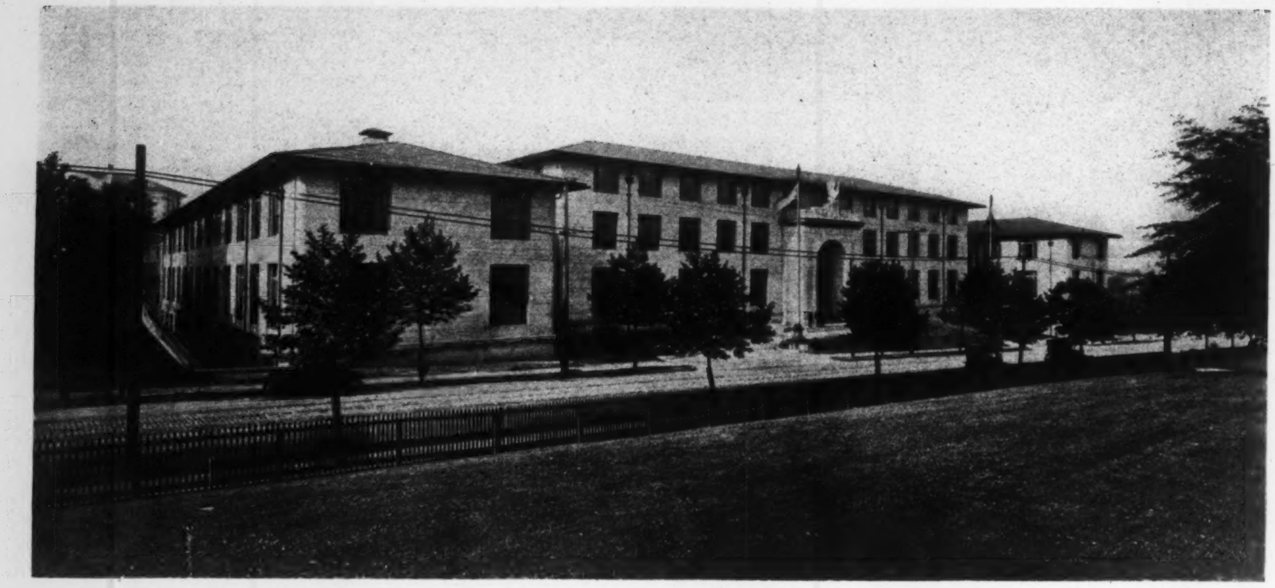
Fig. 11—Equalized fuel and power costs for air conditioning systems

The potential possibilities of independent dehumidification in connection with waste energy utilization and paramount operating economy are illustrated in Fig. 10. A dehumidifier is activated by the high temperature exhaust of an internal combustion engine, which drives a compressor for refrigeration. Another portion of the exhaust may be utilized in an adsorption refrigerator. The compressor may be used in winter for heating by reversed refrigeration, and the engine exhaust and jacket water can do the water heating.

An attempt to equalize electric and gas costs for equal air conditioning capacities when various combined systems are used is represented in Fig. 11.

Statistics on Air Conditioning Orders

Statistics for the month of July on the value of orders booked for air conditioning systems and equipment have been released by the Bureau of Census, Department of Commerce, Washington, D. C. A survey of the figures included in this report indicates that from 98 manufacturers in this particular field that during the first seven months of this year, from January to July, a total of $24,572,299 have been booked and recorded from information supplied by the various individual manufacturers. The total value of orders reported by these same manufacturers during July 1936 amounted to $4,155,853 as compared with $4,336,636 for June 1936.



Pittsburgh Experiment Station of the U. S. Bureau of Mines where the Research Laboratory of the American Society of Heating and Ventilating Engineers is located

Research Goes Ahead

THE A.S.H.V.E. is justly proud of the fact that it is the only professional engineering organization which maintains and operates its own research laboratory and that the sole object of this work for nearly 20 years has been to develop data for the scientific and practical advancement of the art of heating, ventilating and air conditioning.

Since 1919 when the A.S.H.V.E. Research Laboratory was established in the U. S. Bureau of Mines at Pittsburgh, Pa., the Committee on Research, elected by the members of the Society, has determined which problems are to be studied at the Laboratory and in cooperating institutions. The details of each problem are worked out by a Technical Advisory Committee, and this plan assures effective research scientifically accurate, supervised and assisted by the most experienced engineers in the field who serve without remuneration.

Since 1927 the Society has had cooperative agreements with a number of universities where work is carried on under laboratory supervision, and these investigations have provided valuable data, excellent student training, and have aided greatly in broadening the scope of the Society's influence and accomplishments.

At the last meeting of the Committee on Research in June, an enlarged program of research studies was approved and five projects are now underway at the Laboratory in Pittsburgh. Of eight cooperative studies now being made, two are located at the University of Minnesota, one at Marquette University, one at the University of Illinois, one at the University of Illinois Medical College, one at the Harvard School of Public Health, one at the Michigan College of Mining and Technology and one at the Case School of Applied Science.

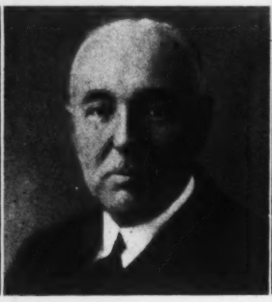
A joint study on the comfort requirement of summer cooling, has been carried on simultaneously during the past few months at the Laboratory at Pittsburgh, the Ontario Research Foundation, Toronto, and at the A. & M. College of Texas.

Among the problems now under investigation are the following:

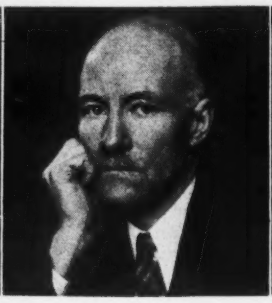
(1) A study of comfort requirements for summer cooling to check the extent to which variations of climatic conditions in several geographical locations affect the desirable indoor temperature;

(2) A determination of the frictional resistance to the flow

D. W. Nelson



C.-E. A. Winslow



W. A. Danielson

C. E. Lewis

Cyril Tasker

C. A. Dunham

W. L. Fleisher

Elliott Harrington

A. P. Kratz

H. C. Murphy

of air through round ducts and fittings to be followed by a comprehensive study of rectangular ducts and fittings;

(3) An investigation of the time and rapidity of change from the summer to the winter comfort zone;

(4) A study of air movement as related to various temperature and humidity conditions to determine what constitutes a draft;

(5) A study of the relative conductivity of concrete mixtures containing various special light aggregates;

(6) Atmospheric dust and air cleaning devices;

(7) Relation between temperature, velocity, direction and location of entering air stream on ventilation conditions within occupied spaces;

(8) The use of refrigeration in the treatment of air;

(9) Air conditioning and its effect on health in the treatment of diseases;

(10) Heat transfer between air and fin tubing;

(11) Odors as a limiting factor in volume of air recirculated in occupied spaces;

(12) Corrosion in steam heating systems.

Many more problems need to be investigated to develop fundamental data for the use of engineers engaged in heating, ventilating and air conditioning work so that every member of the A.S.H.V.E. has a direct interest in the research program. All who hold Member and Associate grade contribute 40% of their annual dues directly to the Research Fund so that they may justly have a feeling of pride that their contribution has aided their profession and has benefited the public. This amount with other substantial contributions from organizations, manufacturers and individuals permits the Society to carry on research effectively and to accomplish maximum results at minimum cost.

The Research Finance Committee has just announced that its objective is to raise a fund of $100,000 for 1936-37 to meet the growing needs of heating, ventilating and air conditioning engineers who require more fundamental data. The profession and its allied industries have been benefited greatly from A.S.H.V.E. Research so their participation in the current program is invited.

St. Louis Plans for the 43rd Annual Meeting in January

Members of St. Louis Chapter will be host to the Society for the 43rd Annual Meeting to be held at Hotel Statler, January 25-27, 1937. A three-day meeting will be held and technical sessions will be held each day. A conference of official representatives from the Society's 21 local chapters has been scheduled and there will be a general discussion of chapter programs and other activities.

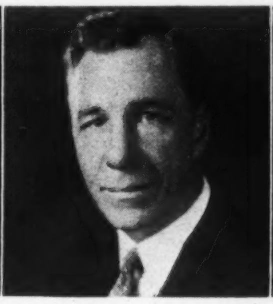
Plans for the entertainment of visiting members and ladies will be directed by the Committee on Arrangements composed of the following:

C. R. Davis, *General Chairman*
L. W. Moon, *Vice-Chairman*
R. J. Tenkonohy, *Reception*
P. W. Sodemann, *Transportation*
D. J. Fagin, *Entertainment*
G. W. F. Myers, *Banquet*
J. W. Cooper, *Ladies*
E. E. Carlson, *Publicity*
C. E. Hartwein, *Finance*

On the technical program there are several research papers prepared by the A. S. H. V. E. Research Laboratory in Pittsburgh and cooperating institutions and among the subjects offered for discussion are the following: Studies of Summer Cooling, Air Duct Design, Stoker Operation, Fan Performance, Conductivity of Concrete, Noise Problems in Ventilation, and Handling Condensate and Air in Vacuum Heating.

C. A. Booth

E. K. Campbell



John Howatt

J. H. Walker

NOMINATIONS FOR 1937

The Nominating Committee appointed to select candidates for Officers of the Society for the coming year, 1937, submits the following list of nominees:

For President:

D. S. Boyden, Boston, Mass.

For First Vice-President:

E. H. Gurney, Toronto, Ont., Can.

For Second Vice-President:

J. F. McIntire, Detroit, Mich.

For Treasurer:

A. J. Offner, New York, N. Y.

For Members of the Council:

Three-Year Term

J. J. Aeberly, Chicago, Ill.
M. C. Beman, Buffalo, N. Y.
E. O. Eastwood, Seattle, Wash.
W. A. Russell, Kansas City, Mo.

Respectfully submitted,

NOMINATING COMMITEE,

J. H. Van Alsburg, *Acting Chairman;*
R. J. Tenkonohy, *Secretary.*

In accordance with the provisions of the Amended Constitution, as given, ballots containing the names of the above candidates will soon be sent to the membership for voting upon prior to the Annual Meeting in January.

Art. B-VIII—Section 10. The Nominating Committee shall consist of one (1) member eligible to vote designated by each Chapter, or his alternate also appointed by the Chapter. The Secretary of each Chapter shall certify to the Secretary of the Society on or before January first the names of the member and alternate selected.

The Committee shall meet at the Annual Meeting of the Society at the call of the Secretary of the Society and shall effect its own organization and elect its own Chairman. At the Semi-Annual Meeting of the Society, if possible, the Nominating Committee shall select the nominees for the ensuing year for the offices of President, First Vice-President, Second Vice-President, Treasurer, and four (4) members of the Council. In any event the names of the nominees shall be certified to the Secretary of the Society before September twentieth, with the written consent of each nominee to fill the office for which he has been selected and their names with the offices to which they have been nominated shall be published in the October issue of the Journal.

Art. B-IX—Section 2. The Secretary shall prepare ballots with the names of all candidates and forward them to the members, eligible to vote, at least thirty (30) days before the date of the Annual Meeting.

Nominations for Members of Committee on Research

Although committees of the Society are usually appointed, in view of the great importance of the Committee on Research and the financial responsibility it would be called upon to assume, it has been made more representative of the entire membership of the Society by a process of *election.* The election is governed by the By-Laws for the election of officers, with the single exception that Members of the Committee on Research are nominated by the Council instead of by a Nominating Committee.

In accordance with the Regulations for the Government of the Research Laboratory, adopted at the January, 1919, Meeting, and amended January, 1933, the Council announces the nomination of the following members of the Committee for election to succeed those members whose present terms expire January, 1937:

Three-Year Term

H. E. Adams, South Norwalk, Conn.
A. E. Stacey, New York, N. Y.
G. L. Tuve, Cleveland, Ohio.
J. H. Van Alsburg, Chicago, Ill.
J. H. Walker, Detroit, Mich.

The regulations governing the nomination and election of members of the Committee on Research are as follows:

Article II—Organization

Section 1. *Committee on Research*—There shall be a standing committee known as the Committee on Research, consisting of fifteen (15) members each serving for three (3) years and five (5) retiring each year. The outgoing Chairman if serving in that capacity during the last year of his three (3) year term on the Committee shall without election become an additional member of the Committee on Research for one (1) year.

(*a*) The Council shall nominate previous to July first of each year five (5) members to fill the vacancies of those retiring at the next Annual Meeting.

(*b*) The nominations made by the Council shall be published in the October issue of the Society's Journal.

(*c*) Any ten (10) members of the Society eligible to vote may present to the Secretary over their signatures, the name of one (1) or more additional nominees for the Committee on Research, provided such name or names are presented at least sixty (60) days prior to the next Annual Meeting, and such additional nominations shall be placed on the ballot opposite the nominations made by the Council.

(*d*) The election shall otherwise conform to the regulations provided for the election of officers of the Society in the Constitution, By-Laws and Rules.

(*e*) Vacancies may be filled by the Council, such persons chosen by the Council to serve until a successor is elected at the next Annual Meeting.

A.S.H.V.E.—A.S.R.E. Joint Committee on National Standards for Air Conditioning Applications

Prof. G. L. Larson and L. S. Morse, respective presidents of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS and the *American Society of Refrigerating Engineers* have just announced the personnel of a joint committee to formulate National Standards for Air Conditioning Applications.

The personnel of the new committee is as follows: A.S.H.V.E. representatives—L. A. Harding, Buffalo, N. Y., John Howatt, Chicago, Ill., D. E. French, Newark, N. J., Prof. A. P. Kratz, Urbana, Ill., and C. W. Walton, Jr., New York, N. Y.; *A.S.R.E.* representatives—Glenn Muffly, Springfield, O., W. L. Fleisher, New York, N. Y., Prof. H. J. Macintire, Urbana, Ill., W. E. Zieber, York, Pa., and L. A. Philipp, Detroit, Mich.

On September 26 President Larson called a meeting at Pittsburgh, Pa., for organization of the committee, the election of a chairman, and to outline the scope of the committee's work. L. A. Harding, Buffalo, was elected chairman, Glenn Muffly vice-chairman, and Prof. A. P. Kratz acted as secretary.

L. A. Harding
Chairman

Glenn Muffly
Vice-Chairman

W. L. Fleisher

D. E. French

John Howatt

A. P. Kratz

H. J. Macintire

C. W. Walton, Jr.

W. E. Zieber

President Larson's Fall Visits to Chapters

Pres. G. L. Larson, Madison, Wis., will attend the fall meetings of a number of A.S.H.V.E. Chapters and his itinerary has been arranged so that he will be in Buffalo October 12; Toronto October 13; Montreal October 14; Detroit October 15; and Grand Rapids October 16.

A second trip will include Chicago November 9, Cincinnati November 10; Cleveland November 11; Philadelphia November 12; Boston November 13, and New York November 16.

Delegates Appointed

The International Congress for Technical Education will be held in Rome, Dec. 28-30, 1936, according to the announcement of the president, E. Labbe.

Official representatives for the A. S. H. V. E. have been named by President G. L. Larson and are Aldo Gini and Chas. F. Hauss of Milan.

National Council Engineering Examiners Annual Convention

The 17th annual convention of the National Council of State Boards of Engineering Examiners will be held at the Hotel Andrew Johnson in Knoxville, Tenn., on October 19, 20, 21, 1936. Individuals attending this convention will include delegates of the various state member boards and those individuals who have been extended personal invitations.

Business to be considered at this convention will include reports of various standing committees, which include Accredited Engineering Schools, Uniform Examinations for Registration, Legal Procedure, National Bureau of Engineering Registration, Engineers' Council for Professional Development, Constitution, and a special Committee on Budget. The afternoon session of the second day of the convention will be set aside for round table discussions of problems of administration and enforcement of registration laws.

At the annual banquet, which is to be held on October 20, an address will be given by Director David Lillienthal of the Tennessee Valley Authority and also a mock session of an examining board will be presented. The following day will include a sightseeing trip to the town of Norris and Norris Dam for the delegates in attendance.

The executive secretary of the National Council is T. Keith Legare with headquarters at Columbia, S. C.

Annual Reports of Local Chapters

Illinois

J. J. Hayes, *President*

C. E. Price, *Secretary*

The Illinois Chapter opens its new year with a dinner meeting at the Hotel Sherman, Chicago, on October 12. The speaker of the evening will be L. D. Gayton, acting city engineer, City of Chicago, and the subject will be Chicago's Water Supply and Disposal Situation as It Affects Air Conditioning. On November 9 a meeting will be held at the Hotel Sherman and Prof. G. L. Larson, of Madison, Wis., president of the A. S. H. V. E., will be the speaker of the evening and will discuss The Economics of Good Construction as Related to Residence Heating. Arrangements are also under way for a meeting on December 14.

The present officers and committees of Illinois Chapter are:

President—J. J. Hayes.

Vice-President—L. S. Ries.

Secretary—C. E. Price.

Treasurer—J. R. Vernon.

Board of Governors—O. W. Armspach, C. E. Crone, Jr., S. I. Rottmayer.

Membership Committee—Tom Brown, *Chairman,* M. W. Bishop, J. R. Borling, C. E. Crone, E. M. Mittendorff, F. I. Raymond, E. W. Rietz.

Meetings and Publication—L. S. Ries, *Chairman,* C. F. Hayden, P. J. Marschall, J. H. Milliken, C. E. Price, S. I. Rottmayer.

Finance Committee—J. R. Vernon, *Chairman,* B. L. Casey, J. P. Fleming, E. N. McDonnell.

Legislative Committee—J. H. O'Brien (*1937*), R. E. Hattis (*1938*), John Howatt ((*1939*).

The number of members on the Illinois Chapter membership roll totals 130 and the annual report of Secy. C. E. Price gives a synopsis of meetings held during the past year.

October 14, 1935. Annual meeting and election of officers. Paper on Adsorbents Used in Air Conditioning, by Ernest Szekely. Attendance—106.

November 18, 1935. Joint meeting with Wisconsin Chapter held in Milwaukee. Paper on Heating Design of a Federal Housing Program, by E. P. Rich, and an address on Housing Research by Prof. G. L. Larson. Fifty Illinois Chapter members attended. In the afternoon an inspection trip was made through the Schlitz Brewery.

December 9, 1935. Presentation by John Howatt of Research Laboratory paper, Comfort Standards for Summer Air Conditioning.

January 13, 1936. Ladies' night and pre-annual meeting. Talk by Dr. A. H. Compton on Cosmic Rays. Attendance—104.

February 10, 1936. Paper on Pullman Car Air Conditioning, by H. M. Winther. Attendance—87.

March 9, 1936. Paper on The Effect of Weather on Man, by Dr. W. F. Petersen. Attendance—70.

April 13, 1936. Paper on P.W.A. in Action, by C. H. Bauer. Attendance—96.

May 11, 1936. Election of officers. Papers on Conditioning Operating Rooms, Billings Hospital, University of Chicago, by W. L. Krogman, and Air Conditioning Requirements in a Candy Factory, by R. W. Shields. Attendance—73.

Philadelphia

W. F. Smith, *President*

H. H. Erickson, *Secretary*

Philadelphia Chapter has arranged programs for the first three meetings of the 1936-37 season, beginning in October when the subject of Fractional Hp Motors, Their Selection and Application to the Heating and Ventilating Industry will be discussed by B. S. Weaver, General Electric Co. Prof. G. L. Larson, president of the A.S.H.V.E., will be guest of honor and speaker at the November meeting, and in December C. S. Leopold, consulting engineer, will speak on Air Conditioning.

Secy. H. H. Erickson of Philadelphia Chapter has reported a total membership of 116, including 87 Members, 19 Associate Members, 5 Junior Members, and 5 Life Members.

The Philadelphia Chapter officers and committees are:

President—W. F. Smith.

Vice-President—L. P. Hynes.

Secretary—H. H. Erickson.

Treasurer—R. F. Hunger.

Board of Governors—J. H. Hucker, S. E. Plewes, C. B. Eastman, and the officers.

Membership Committee—A. E. Kriebel, *Chairman,* R. C. Bolsinger, J. M. Jopson, S. E. Plewes, E. C. Powers.

Meetings Committee (Includes Publicity Committee)—C. B. Eastman, *Chairman,* M. G. Kershaw, H. H. Mather, L. E. Moody, E. C. Powers.

Legislative Committee—F. D. Mensing, *Chairman,* M. F. Blankin (2 years), W. P. Culbert (3 years).

Finance Committee—R. F. Hunger, *Chairman,* W. A. Bornemann, J. H. Hucker.

Year Book Committee—A. E. Kriebel, *Chairman,* H. H. Erickson.

Attendance Committee (Membership Sub-Committee)—A. H. MacDade, *Chairman,* H. M. Patrick.

A synopsis of meetings held from October 1935 to May 1936 inclusive is given in the secretary's annual report.

October 10, 1935. Engineers Club. Attendance—50 members and 10 guests. Speaker—C. F. Mowrey, district new business manager, Peoples Gas & Electric Co., Oswego, N. Y. Subject—Heating by Reversed Refrigeration Utilizing Gas and Its Sequel. Mr. Mowrey's paper included extracts from articles which he had previously published on this subject and additional new data which he had prepared.

November 14, 1935. Engineers Club. Attendance—100. This was a joint meeting with the local section of *A.S.R.E.* and was preceded by a dinner. The paper, Comfort Standards for Summer Air Conditioning, was read by Harry Harrison, president of *A.S.R.E.,* and the discussion which followed brought out some valuable comments from members of both groups. The paper was well received and the meeting proved to be one of the most interesting and educational.

December 12, 1935. Engineers Club. Attendance—36. Speaker P. L. Davidson, Carrier Engineering Corp. Subject—Air Conditioning. This paper presented the picture of air conditioning from a practical as well as an interesting viewpoint, and proved to be one of the most valuable papers presented during the season.

January 9, 1936. Hudson Recreation Centre. Attendance—110. This was the annual play meeting at which the sport of bowling was engaged in after a real Dutch buffet supper was served.

February 13, 1936. Engineers Club. Attendance—26. This was a night of sleety weather and the poor attendance was attributed to the inability of members to reach the meeting. An informal discussion of the many phases of the heating, ventilating and air conditioning profession was engaged in and interesting problems were given for solution by the members present.

March 12, 1936. Engineers Club. Attendance—45 members and six guests. Speaker—W. N. Bateman, president, Solgas Co., Inc. Subject—Liquid Petroleum for House Heating. Mr. Bateman described this gas for fuel derived from petroleum, giving details of its development and possibilities.

April 9, 1936. Engineers Club. Attendance—60. Speaker—H. H. Mather, Philadelphia Electric Co. Subject—Economic Influences Affecting the Future of Air Conditioning. Mr. Mather discussed the subject in an interesting manner and gave a clear picture of air conditioning from the economic viewpoint. Mr. Mather's association with the development of air conditioning enabled him to present worthwhile facts on the question of Does Air Conditioning Pay Returns.

May 14, 1936. Spring Haven Country Club. Attendance—100. At this meeting Philadelphia Chapter was honored with the presence of Prof. G. L. Larson, Madison, Wis., president of the A.S.H.V.E., who made some interesting remarks. This last meeting of the season was preceded by a golf tournament.

Ontario

Thomas McDonald,
President

H. R. Roth, *Secretary*

A golf game at Weston Golf and Country Club on September 28, 1936 opened activities of the fall season of Ontario Chapter. On October 13 President G. L. Larson, Madison, Wis., will be guest of honor and speaker, discussing the subject of The Economics of Good Construction as Related to Residence Heating. At the November 2 meeting, Weather in Canada will be discussed by A. T. Connor, Dominion climatologist.

Ontario Chapter numbers 89 on its membership roll and the officers and committees serving are:

President—Thomas McDonald.
Vice-President—G. A. Playfair.
Secretary-Treasurer—H. R. Roth.
Board of Governors—H. B. Jenney, H. D. Henion, J. W. O'Neill.
Greeters—W. P. Boddington, *Chairman,* A. G. Ritchie, W. G. Sheppard.
Papers Committee—Cyril Tasker, *Chairman,* L. L. Anthes, E. H. Gurney, M. F. Thomas, M. B. Watson.
Auditors—G. H. Hopper, C. D. Waldon.
Entertainment Committee—E. R. Gauley, *Chairman,* H. J. Church, W. C. Kelly, Arthur Wardell.
Attendance Committee—A. H. Hills, *Chairman,* Ernest Fox, J. H. Fox, S. A. Jennings, J. J. Lawlor, J. M. S. Marriner, D. I. Paul, William Philip, E. T. Whittall.
Membership Committee—O. L. Maddux, *Chairman,* H. H. Angus, *Vice-Chairman,* S. W. Alexander, R. P. Allsop, W. C. Oke, D. O. Price.

A synopsis of meetings held during the past year has been included in the annual report of Secretary Roth.

October 7, 1935. Golf tournament at Weston Golf and Country Club. Attendance—41 members and guests.

November 4, 1935. F. C. Houghten, Pittsburgh, Pa., director of the A.S.H.V.E. Research Laboratory, spoke on Comfort Cooling. Attendance—62 members and guests.

December 2, 1935. R. T. Kelly discussed Canada's Future. Attendance—41 members and guests.

January 6, 1936. Prof. E. A. Allcut, University of Toronto, spoke on Heat Transmission Through Materials. Attendance—48.

February 10, 1936. Mr. McIntosh discussed Aluminum Foil Insulation and Allyne Rooke spoke on The Manufacture of Tubing. Attendance—45.

March 2, 1936. Cyril Tasker gave an address on Research the Fact Finder. Attendance—27.

April 6, 1936. E. L. Anderson spoke on the subject of Sound in Relation to Air Conditioning. Attendance—55.

May 4, 1936. This was the annual meeting and 36 were present.

Pittsburgh

R. J. J. Tennant, *President*

T. F. Rockwell, *Secretary*

The following officers and committees are in charge of activities of Pittsburgh Chapter, which numbers 45 on its roll of membership:

President—R. J. J. Tennant.
Vice-President—M. L. Carr.
Secretary—T. F. Rockwell.
Treasurer—J. F. Collins, Jr.
Board of Governors—L. B. Pittock, P. Nicholls, E. S. Tower.
Program Committee—M. L. Carr, *Chairman,* F. C. Houghten, H. L. Moore, W. H. Osterle, W. W. Stevenson.
Membership Committee—F. C. McIntosh, *Chairman,* Roy Brauer, P. A. Edwards, E. C. Smyers, P. C. Strauch.
Attendance and Social Committee—R. B. Stanger, *Chairman,* T. M. Dugan, L. S. Maehling, Peter O'Neill, E. H. Riesmeyer, Jr.
Code Committee—G. S. McEllroy, *Chairman,* P. A. Edwards, G. G. Waters.

A resumé of the meetings held during 1936 has been prepared by Secretary Rockwell.

January 13, 1936. Speaker: E. B. Svenson, Aluminum Co. of America. Subject: Use of Aluminum Foil as a Heat Insulation Material. Attendance: 18 members and 34 guests.

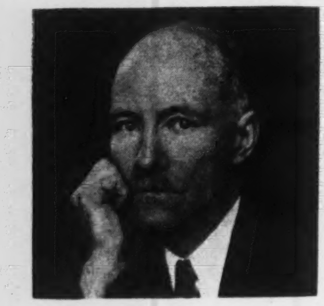
February 10, 1936. Speaker: R. A. Miller, Pittsburgh Plate Glass Co. Subject: Glass. Attendance: 20 members and 12 guests.

March 9, 1936. Speaker: T. M. Dugan, National Tube Co. Subject: Cross Connections in Plumbing. Attendance: 17 members and 18 guests.

April 13, 1936. Speaker: F. A. Gunther. Subject: Progress Report of Committee for Study of the Degree Day. Attendance: 15 members and 14 guests.

May 11, 1936. Speakers: Prof. G. L. Larson, Madison, Wis., president of the A.S.H.V.E., and Lt. Col. W. A. Danielson, Washington, D. C., chairman of the Society's Committee on Research. Subjects: Economics of Insulation; New Organization of Research Activities. Attendance: 21 members and 18 guests.

Washington, D. C.



W. A. Danielson, *President*

M. D. Kiczales, *Secretary*

Washington, D. C. Chapter numbers 48 on its membership roll and the following officers and Membership Committee are working effectively:

President—W. A. Danielson.
Vice-President—T. H. Urdahl.
Secretary—M. D. Kiczales.
Treasurer—W. E. Kingswell.
Board of Governors—E. J. Febrey, G. S. Frankel, L. S. Ourusoff.
Membership Committee—R. H. Feltwell, *Chairman*, W. F. Coddard, S. L. Gregg, J. B. Hewett, E. H. Lloyd, J. G. Vaughan, Jr.

A synopsis of meetings held during 1935-36 has been prepared by Secretary Kiczales.

September 25, 1935. Organization meeting. Present: 10 members of the Society.

October 9, 1935. Meeting for further organization. Present: 31 members and prospective members. Tour of inspection through the Department of Justice Building. Mr. Galloway, of the Department of Public Buildings, aided by the superintendent of the building, showed the party the air conditioning system and explained its operation, and Mr. Tracy, an assistant of J. E. Hoover, conducted the party on a trip through the Crime Laboratory.

November 18, 1935. Regular monthly meeting. Present: 41 members and prospective members at dinner; 57 members, prospective members and guests at the business meeting. Paper delivered by W. L. Fleisher, consulting engineer, New York, and a member of the A.S.H.V.E. Council, on Comfort Standards for Summer Air Conditioning, which was followed by discussion.

December 11, 1935. Regular monthly meeting. Present: 34 members and guests at dinner; 100 members and guests at the business meeting. Paper delivered by L. S. Ourusoff, engineer of utilization, Washington Gas Light Co., on Independent Dehumidification—The Application of Silica Gel, which was later discussed. This was followed by an inspection of a typical installation in the building of the Washington Gas Light Co.

January 8, 1936. Regular monthly meeting. Present: 53 members and guests at dinner, including Maj. Gen. C. B. Reynolds, Surgeon General of the United States Army, Dr. W. G. Morgan, dean of the School of Medicine, Georgetown University, and W. E. Reynolds, assistant director, Procurement Division, U. S. Treasury Department. Present at the business meeting: approximately 400 members and guests. L. Sherman, Vinco Co., New York, gave a demonstration of water treatment for steam boilers, using a glass model. Address delivered by Dr. C. A. Mills, professor of experimental medicine, University of Cincinnati, on The Physiologic and Medical Aspects of Air Conditioning.

February 12, 1936. Charter meeting. Present: 47 members and guests at dinner and at the business meeting. A. J. Offner, New York, treasurer of the A.S.H.V.E., presented the charter, with an address of welcome. The charter was accepted on behalf of the Chapter by Colonel Danielson, who spoke briefly of the work and objects of the Research Committee of the Society. Short talks were given by E. J. Febrey, R. H. Feltwell, and S. F. Gardner.

March 11, 1936. Regular monthly meeting. Present: 55 members and guests at dinner; 70 members and guests at business meeting. Dr. C. A. Mills, University of Cincinnati, and Col. C. M. Walson, Surgeon General's office, were guests of the Chapter. Dr. Mills gave a short talk, and President Danielson related a few interesting events which occurred during his travels in connection with work as chairman of the Committee on Research. W. E. Kingswell presented Automatic Controls, a talking picture produced by Minneapolis-Honeywell Regulator Co. Mr. Kingswell explained the picture which showed combinations of automatic controls for heating, ventilating and air conditioning systems.

April 8, 1936. Regular monthly meeting. Present: 40 members and guests at business meeting. A short talk on Smoke Prevention was given by Mr. Kugel, smoke inspector of the District of Columbia. Mr. Kugel told of the cooperation of the Smoke Committee of the *Cleveland Engineering Society* and the Cleveland Chapter of the A.S.H.V.E. in smoke abatement work in that city, and emphasized the responsibility of the designing engineer for smoke conditions in the community. A paper was delivered by A. J. Johnson, director of the Anthracite Institute Laboratory, entitled, The Design of Improved Heating Equipment, followed by a general discussion.

May 13, 1936. Regular monthly meeting. Present: 46 members and guests at dinner; 53 members and guests at business meeting. Pres. G. L. Larson, Madison, Wis., president of the A.S.H.V.E., spoke on the Research Work of the Society. S. L. Guthorn, superintendent of the Procurement Division of the Treasury Department and of the buildings of the Triangle Group, described briefly the air conditioning installation in the Archives Building, preliminary to an inspection of that installation, which was made later in the evening under the guidance of Mr. Guthorn and E. J. Motley, chief engineer of the Archives Building.

Montreal

G. L. Wiggs, *President*

C. W. Johnson, *Secretary*

Montreal Chapter will begin its fall activities with a meeting on October 13 at 6:30 p. m. at the Windsor Hotel when Prof. G. L. Larson, Madison, Wis., president of the A.S.H.V.E., will be guest and speaker. President Larson's subject will be Economics of Good Construction as Related to Residence Heating. At this meeting it is also planned to name committee appointments for the season.

The officers and Board of Governors of the Montreal Chapter are:

President—G. L. Wiggs.
Vice-President—F. J. Friedman.
Secretary—C. W. Johnson.
Treasurer—F. G. Phipps.
Board of Governors—A. B. Darling, T. E. McGrail, J. P. Linton.

The Chapter now has 35 members, and an outline of the organization meeting held during the past year is given in the annual report of Secy. C. W. Johnson.

May 11, 1936. An organization meeting was held at the Queen's Hotel and was attended by 60 members and guests. E. H. Gurney, Toronto, second vice-president of the A.S.H.V.E., was present and discussed the advantages of belonging to the A.S.H.V.E., Society activities, the benefits of participating in local chapter affairs, as well as attendance at Annual and Semi-Annual Meetings of the Society. A. V. Hutchinson, secretary, was present and spoke on the History of the A.S.H.V.E.

Manitoba

J. B. Steele, *President*

C. H. Turland, *Secretary*

Meetings of Manitoba Chapter are held at Fort Garry Hotel, Winnipeg, beginning with dinner at 6:00 p. m. Pres. G. L. Larson was a guest at the first gathering of the fall season held September 11. In October several Chapter members will give brief talks, and in November Prof. N. M. Hall, University of Manitoba, will be guest speaker and will describe Experiences with the Hudson Bay Mining & Smelting Plant at Flin Flon, Man. The December meeting will be a social gathering on a date coming close to Christmas.

Manitoba Chapter now has 17 members on its rolls and activities are in charge of the following officers and committees:

President—J. B. Steele.

Vice-President—D. F. Michie.

Secretary—C. H. Turland.

Treasurer—H. R. Eade.

Board of Governors—William Glass, Frank Thompson, J. E. Yates.

Membership Committee—R. L. Kent, *Chairman*, H. R. Eade, E. Fitz Munn.

Technical Programs—D. F. Michie, *Chairman*, E. Fitz Munn, Frank Thompson.

Nominating Committee—Frank Thompson, *Chairman*, James Aitken, C. H. Turland.

Air Conditioning Standards Committee—R. L. Kent, *Chairman*, E. J. Argue, H. R. Eade, H. R. Glass, D. F. Michie, C. H. Turland.

An outline of meetings which have occurred since the organization of the Chapter has been given by Secy. C. H. Turland.

December 18, 1935. This was the organization meeting of the Chapter, when officers were elected. Following the installation ceremonies, a general discussion was held. Attendance—11 members.

January 23, 1936. Committees were appointed and other matters of routine business were completed. D. F. Michie presented a paper on Air Conditioning Standards for discussion. Attendance—11 members.

March 4, 1936. A business meeting was held with 12 members and 3 guests present.

March 26, 1936. J. W. Sanger, chief engineer, Winnipeg Hydro-Electric System, was guest speaker, his subject being Hydro in Winnipeg. Attendance 12 members and 9 guests.

April 23, 1936. The speakers were C. A. Clendenning and G. C. Davis, of Winnipeg Heating Co., who discussed District Heating. Attendance—9 members and 2 guests.

May 28, 1936. This was Ladies Night and a dinner and bridge were enjoyed by 9 members and 6 guests.

Michigan

R. K. Milward, *President*

G. H. Tuttle, *Secretary*

The fall activities of Michigan Chapter will start on October 15 with the visit to Detroit of Pres. G. L. Larson, Madison, Wis., who will be guest of honor. Tentative programs for the remainder of the year are well formulated as follows: *November*—H. H. Reinecke, chief of the Detroit Federal Bureau of Investigation; *December*—Discussion of research paper; *January*—Meeting sponsored by the Detroit Edison Co.; *February*—Annual dinner dance; *March*—University night; *April*—open; *May*—Golf and election of officers.

Approximately 100 members are on the roll of Michigan Chapter and the officers and committee chairmen for the 1936-37 season are:

President—R. K. Milward.

Vice-President—F. J. Feely.

Secretary—G. H. Tuttle.

Treasurer—A. P. Darlington.

Board of Governors—R. F. Connell, F. J. Linsenmeyer, F. R. Bishop, G. D. Winans.

Membership Committee—W. G. Boales, *Chairman*.

Program Committee—G. D. Winans, *Chairman*.

Reception Committee—J. S. Kilner, *Chairman*.

A synopsis of meetings held during the season of 1935-36 is given by Secy. G. H. Tuttle.

October 8, 1935. John Howatt, Chicago, Ill., president of the A.S.H.V.E., was guest of the Chapter, and discussed Our Changing World with particular reference to the heating and ventilating industry. He also discussed briefly the Society's plans for the coming year. Approximately 60 members and guests were present.

November 11, 1935. Inspection trip through Detroit's new Springwells Pumping Station. Pres. A. C. Wallich introduced several engineers in charge of the plant and the chief engineer, who gave a short talk on the pumping station. Approximately 75 members and guests attended the meeting.

December 16, 1935. S. S. Sanford, Detroit Edison Co., presented the research paper, Comfort Standards for Summer Air Conditioning. He traced the origin of effective temperature, and by means of charts explained the tests being conducted by the Society. Following his presentation, there was considerable discussion of the subject. Approximately 55 attended the meeting.

January 15, 1936. This meeting was sponsored by the Detroit Edison Co. and about 100 attended. Messrs. D. H. Corie and R. M. Van Duser, engineers, discussed recent developments in pipe welding as adopted in the revamping of Conners Creek Power Station. After the technical meeting, two movies were shown.

February 17, 1936. The Michigan Chapter's annual dinner dance was held at the Wardell Hotel with 73 in attendance.

March 16, 1936. This was the annual University Night and the meeting was held in the Engineering Building of the University of Detroit. Prof. A. D. Moore, University of Michigan, demonstrated and discussed the Hydrocal, a short-cut calculating machine for solving heat flow problems. Prof. F. J. Linsenmeyer, University of Detroit, discussed Heating and Air Conditioning of the Motor Car.

April 20, 1936. Hon. E. T. Conlon, assistant attorney general of the State of Michigan, discussed State Taxes in Relation to Business. A. C. Schubring, research and development engineer, Michigan Alkali Co., spoke on The Manufacture, Distribution and Future of Dry Ice. Approximately 50 attended the meeting.

Oklahoma City

The 1936-37 season will be opened by Oklahoma City Chapter with a meeting on October 12, when Prof. F. E. Giesecke, director of the Engineering Experiment Station, Agricultural and Mechanical College of Texas, will present a paper on Field Studies of Air Conditioning Systems. At the November 11 meeting a paper on the Differential System of Heating will be given by C. A. Thinn, C. A. Dunham Co., Chicago, Ill., and plans for the December 14 program are under way.

Activities are under the direction of the following officers and standing committees and the Chapter numbers 11 on its membership roll:

President—F. X. Loeffler.
Vice-President—E. F. Dawson.
Secretary—E. W. Gray.
Board of Governors—S. L. Rolland, R. G. Dolan, Edwin Jones.
Membership Committee—H. W. Meinholtz, *Chairman*, A. D. Holmes, A. A. Hoppe.
Committee on Minimum Standards for Air Conditioning—S. L. Rolland, *Chairman*, G. M. Basore, E. S. Constant, R. G. Dolan, A. A. Hoppe, H. W. Meinholtz, B. R. Miller, R. M. Schulte, Dean Spencer, Bert Stotz, Henry Wilson, George Wymore.

Secy. E. W. Gray has presented a synopsis of activities during the past season.

December 16, 1935. Organization meeting was held with 40 present. The election of officers and the appointment of D. K. Middleton, R. W. Schulte and I. G. Howlett as a Committee on By-Laws took place. Pres. John Howatt, Chicago, Ill., presented the paper, Comfort Standards for Summer Air Conditioning.

January 13, 1936. This meeting was largely devoted to completion of organization and the appointment of the Board of Governors. Attendance—20. The Chapter's Constitution and By-Laws were discussed and accepted.

February 10, 1936. D. D. Wile, Detroit Lubricator Co., Detroit, Mich., spoke on Thermostatic Expansion Valves. Attendance—35.

March 9, 1936. P. D. Close, Celotex Co., Chicago, Ill., presented a paper on Insulation as It Relates to Air Conditioning. The Membership Committee and Committee on Minimum Standards for Air Conditioning were appointed. Attendance—30.

April 3, 1936. Pres. G. L. Larson, Madison, Wis., was a guest and spoke on The Economics of Good Construction as Related to Residence Heating. Air Conditioning Standards also were discussed. Attendance—30.

May 11, 1936. The meeting was held at the University of Oklahoma on invitation of Prof. W. H. Carson and Prof. E. F. Dawson of the School of Mechanical Engineering. The meeting was preceded by a tour of the engineering buildings and dinner at the Student Union. B. E. Shaw, research chief, Penn Electric Switch Co., Des Moines, Ia., spoke on Cooperative Study of Combustion Results with Various Thermostats. Attendance—35.

Manitoba Chapter Host to President Larson

September 11, 1936. Manitoba Chapter had the pleasure of being host to Prof. G. L. Larson, of Madison, Wis., president of the A.S.H.V.E. at this special meeting. An informal dinner was held at 6:00 p. m. to give the 17 members and guests the opportunity of meeting President Larson, who spoke on the aims and objects of the Society and also told of some of his previous Canadian visits. Other speakers at the dinner were Prof. N. M. Hall, H. R. Eade, and J. E. Yates, Sr.

After dinner the members and guests adjourned to Theatre A, University of Manitoba, being joined there by approximately 50 friends and others interested in President Larson's illustrated lecture on The Economics of Good Construction as Related to Residence Heating. This proved interesting to all present and was followed by an informal discussion, when President Larson answered many questions to the satisfaction of all concerned. A vote of thanks was moved by Secretary Turland before the meeting adjourned at 10:30 p. m.

Thermodynamics for Engineers

Although Sir J. A. Ewing's Thermodynamics is primarily intended for engineers, its use may also be of service to students of physics and others who wish to acquire a working knowledge of the first principles of thermodynamics from the physical standpoint.

In presenting the fundamental notions of thermodynamics the author has adopted a method which his experience as a teacher has encouraged him to think useful.

The notions are first introduced in a non-mathematical form; the reader is made familiar with them as physical realities, and learns to apply them to practical performance; then, and not until then, does he study the mathematical relations between them. In accordance with this plan the book gives these elementary notions and their interpretation in practice and defers the study of general thermodynamics relations until near the end. Finally these relations are illustrated by applying them to characteristic equations of fluids and in particular to steam.

The chapter on internal combustion engines gives occasion for introducing some results of experiments on internal energy and specific heats of gases and this matter is dealt with further in another chapter which attempts an elementary account of the molecular theory.

The theory of refrigeration is aptly covered in a chapter which emphasizes the various theoretical cycles and their application to practical refrigerating machines.

In the exposition of the first principles of thermodynamics it is highly desirable to select a way of dealing with temperature, such that the student or engineer may be led by simple or logical steps to understand the thermodynamic scale. In this book a course is followed which presents to the reader the problem of imagining an ideal gas, which serves as a thermometric substance and also as a working substance in a Carnot engine. This gives a perfect gas scale by reference to which the efficiency of any Carnot cycle is provisionally expressed and from that step to the thermodynamic scale is comparatively simple.

This volume is available from Cambridge, England, at the University Press and New York at the Macmillan Co., 60 Fifth Ave., at $6.00 per copy and includes 389 pages.

Smoke and Boiler Manual

The *Smoke Prevention Association* has released a Manual of Smoke and Boiler Ordinances and Requirements to assist in the intelligent abatement of the smoke nuisance, the preservation of health and the conservation of fuel. It is the aim of this pamphlet to satisfy a demand for information on this subject from municipalities seeking the establishment of anti-smoke ordinances, for architects, boiler and smoke eliminating device manufacturers, engineers, contractors, chimney builders, railroad and marine interests.

Comprehensive data are given for determining reasonable and practical smoke densities, periods of smoke allowed for starting and cleaning fires, requirements for installation of fuel burning equipment, penalties for violation of such ordinances, personnel of smoke abatement forces, and the necessary equipment required.

This manual may be obtained from Columbus D. Behan, *Smoke Prevention Association*, City Hall Square Building, Chicago, Ill.

Fuel Oil Equipment Economic Survey

The Oil Burner Institute of New York City has recently released a bound pamphlet, Economic Survey of Fuel Oil and Oil Burning Equipment, which includes innumerable charts and tables drawn from several authoritative sources. The relation of fuel oil consumption and its application to oil burning equipment for heating is accurately and interestingly reflected in the statistics included in this report.

This booklet may be obtained from the Oil Burner Institute, 30 Rockefeller Plaza, New York, N. Y.

N. Loring Danforth Dies

The death of N. Loring Danforth, which occurred at his summer home in Rose Hill, Ont., Canada, on August 28 is regretfully recorded, for Mr. Danforth had been a Member of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS since 1919 and was well known in the contracting field and in Buffalo civic affairs and welfare activities. He served as a member of the Board of Governors of Western New York Chapter during 1922.

Mr. Danforth was born September 26, 1879 at Buffalo, N. Y. and received the degree of S.B. in 1901 from Massachusetts Institute of Technology. In the two subsequent years he served as engineer in the textile industry in New England, and then joined the mechanical equipment contracting firm of John W. Danforth Co., organized by his father in 1893 and of which he became president in 1911.

In addition to conducting his engineering business, Mr. Danforth's interests were many and varied. He had been a member of the Buffalo Chamber of Commerce since 1904 and in 1925 he served as president. He was a trustee of the Buffalo Savings Bank since 1929 and a former trustee of the Marine Trust Co. Since 1926 he had been a member of the council of the University of Buffalo and he served on the Board of Trustees of the Nichols School since 1921 and was president of the board from 1930 to 1935.

Mr. Danforth conducted the joint charities and community fund campaign in 1924, and he was elected vice president of the governing committee in 1935 and served on the executive committee for 10 years.

Mr. Danforth was a member of the Board of Directors of the *Heating, Piping and Air Conditioning Contractors National Association* for three terms from 1914-1924. He was chairman of the Board during 1916-1918, vice-president of the Association 1920-1921 and president during 1921-1922. He was a member of the Builders Exchange, *American Society of Mechanical Engineers,* and was president of the Buffalo Athletic Club in 1930 and held membership in the Buffalo, Buffalo Country, Cherry Hill Country, Rotary, University and the Eliott Clubs.

Surviving Mr. Danforth are his widow, Mrs. Theodora Clapp Danforth; two daughters, Miss Lucy Blake Danforth and Mrs. Edward H. Guthrie; two sons, Dr. Theodore Loring Danforth and John Loring Danforth, all of Buffalo; and two sisters, Miss Grace L. Danforth of Buffalo and Mrs. Thomas C. Pears of Philadelphia.

Mr. Danforth will be greatly missed by all who knew him and the Officers and Council of the Society express their sincerest sympathy to his family in their bereavement.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 21 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn the Council, urge the members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by October 15, 1936, these candidates will be ballotted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
BARNSLEY, F. R., Mgr. Htg. & Cooling Div., Can. General Elec. Co., Montreal, Que., Can.	G. L. Wiggs G. H. Osborne	C. W. Johnson W. U. Hughes
BERZELIUS, C. E., 1st Lt., U. S. Army, Minneapolis, Minn.	F. B. Rowley A. B. Algren	J. E. Swenson H. E. Gerrish
DEANE, J. H., Sales Engr., Detroit Lubricator Co.,Chicago, Ill.	C. W. De Land J. R. Vernon	A. P. Brown Tom Brown
ESTES, E. C., Mech. Draftsman, Northern Pacific Ry., St. Paul, Minn.	A. B. Algren F. B. Rowley	H. E. Gerrish H. C. Betts (*Non-Member*)
GRIESSER, C. E., Owner, C. E. Griesser, Electrical Contractor, Bryan, Texas.	F. E. Giesecke W. H. Badgett	W. E. Long C. W. Crawford (*A.S.M.E.*)
HAUCK, E. L., Sales Mgr. & Engr., Hauck Bros., Springfield, Ohio.	C. L. Sapp V. G. Marconett	F. L. Palmer (*Non-Member*) William Pusch (*Non-Member*)
HILDRETH, E. S., Air Cond. Promotional Engr., Indianapolis Power & Light Co., Indianapolis, Ind.	J. B. Bailey (*Non-Member*) G. A. Young (*Non-Member*)	G. R. Popp (*Non-Member*) W. T. Miller (*Non-Member*)

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
James, R. E., Mgr. Htg. Dept., Harry Cooper Supply Co., Springfield, Mo.	C. W. Adams W. A. Russell	F. F. Dodds Carl Clegg
King, A. C., Consulting Engr., Chicago, Ill.	J. J. Hayes S. M. Trumbo	J. C. Matchett W. T. Walters
Knapp, J. H., Designing Engr., Utica Products Corp., Utica, N. Y.	W. F. McCann (*Non-Member*) R. C. Van Denbergh (*Non-Member*)	W. C. Murray (*Non-Member*) Angela DeRosa (*Non-Member*)
Leonhard, L. W., Supervisor (Paper Sens. Dept.), Eastman Kodak Co., Rochester, N. Y.	W. C. Randall Roswell Farnham	R. P. Cook K. Huse (*Non-Member*)
Malone, J. S., Dist. Sales Repr., Hoffman Specialty Co., St. Louis, Mo.	E. A. White L. W. Moon	D. J. Fagin E. E. Carlson
Mills, Dr. C. A., Prof., Experimental Medicine, University of Cincinnati, Cincinnati, Ohio.	T. H. Urdahl W. A. Danielson	W. E. Kingswell J. B. Hewett
Phillips, R. E., Consulting Mech. & Elec. Engr., Los Angeles, Calif.	O. W. Ott A. G. Orear	H. M. Hendrickson W. E. Barnum, Jr.
Storms, R. M., Consulting Engr., Storms & Gibbs, Los Angeles, Calif.	A. J. Offner O. W. Ott	A. G. Orear W. E. Barnum, Jr.
Stravitsch, J. J., Estimator & Sales, Standard Air, Inc., New York, N. Y.	H. W. Fiedler W. W. Timmis	W. K. Walker A. E. Schoenfeld (*Non-Member*)
Sydow, L. J., Owner, Colonial Htg. & Sheet Metal Co., St. Louis, Mo.	J. M. Foster F. B. Fillo	D. J. Fagin L. W. Moon
Todd, M. L., Htg., Vtg. & Air Cond. Engr., M. L. Todd, Waterloo, Iowa.	William McNamara R. H. Anderegg	M. W. Miller R. N. Trane
Wahrenbrock, O. K., Air Cond. Engr., Automatic Appliance Corp., Stamford, Conn.	L. W. Hoyt D. W. McLenegan	E. D. Harrington R. U. Berry (*Non-Member*)
Wilson, E. D., Gen. Mgr. in India, Carrier Engrg. Co., Ltd., London, S. W. 1, England.	W. H. Carrier Donald French	L. L. Lewis W. A. Grant
Wyatt, D. H., Consulting Mech. Engr., Columbus, Ohio.	D. B. Poling A. W. Williams	O. J. Wheeler A. I. Brown

Candidates Elected

In past issues of the Journal of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and ballotted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. 8, of the By-Laws, the following list of candidates elected:

MEMBERS

Chen, S. T., Director & Partner, American Engrg. Corp., Shanghai, China.

Dever, H. F., Mgr., Minneapolis-Honeywell Reg. Co., Philadelphia, Pa. (*Advancement*).

Dickson, G. P., Dist. Mgr., B. F. Sturtevant Co., Boston, Mass. (*Reinstatement*).

Estep, L. G., Design Engr., Kelvinator Corp., Detroit, Mich.

Goodwin, E. W., Sr. Mech. Engr., U. S. Treasury Dept., Washington, D. C.

Kawase, Sumio, Chief Htg. Engr., Eizen Kyoku, Hsinking, Manchoukuo.

Kinney, A. M., Pres., A. M. Kinney, Inc., Cincinnati, Ohio.

Kraminsky, Victor, Managing Director & Chief Engr., Air Cond. & Engrg., Ltd., London, S. W. 1, England.

Kuempel, L. L., Mgr. Modutrol Div., Minneapolis-Honeywell Reg. Co., Atlanta, Ga. (*Advancement*).

Nee, R. M., Head of Engrg. & Utilization Div., Edison Elec. Illuminating Co. of Boston, Boston, Mass.

Reynolds, T. W., Consulting Engr., Hastings-on-Hudson, N. Y. (*Reinstatement*).

Rothmann, S. C., Industrial Hygiene Engr., State Health Dept., Charleston, W. Va.

Stermer, C. J., Engr., Crane Co., Chicago, Ill.

Terry, M. C., Chief Engr., Standard Air Cond., Inc., New Rochelle, N. Y.

ASSOCIATES

Allen, W. W., Mgr. & Engr., American Coolair Corp., Jacksonville, Fla.

Brightly, F. C., Jr., Vice Pres., Standard Galvanizing Co., Chicago, Ill.

Koehler, C. S., Sales Engr., Minneapolis-Honeywell Reg. Co., New York, N. Y.

Laffoley, L. H., Asst. Engr., Canadian Pacific Rly., Montreal, Que., Can.

Nelson, A. W., Mgr., Brockton Oil Heat, Inc., Brockton, Mass.

Pratt, J. C., Air Cond. Engr., Canada Gen. Elec. Co., Montreal, Que., Can.

Ruple, P. E., Htg. Contractor, Bradford Oil Burner Co., Bradford, Pa.

Wissing, C. B., Sales Mgr., Ebner Ice & Cold Storage Co., Vincennes, Ind.

JUNIORS

Blum, Herman, Jr., Jr. Engr., Crawford, Inc., New Orleans, La.

Hamje, M. C., Engr., Syska & Hennessy, New York, N. Y.

Leichnitz, R. W., Engr. & Estimator, Leichnitz Engrg. Co., Yakima, Wash.

Morris, J. A., Htg. Engr., The James Robertson Co., Ltd., Montreal, Que., Can.

Murray, H. G. S., Sales Engr., Humidaire Co., Ltd., Montreal, Que., Can.

Oldes, W. E., Draftsman & Designer, Dept. of Purchase, New York, N. Y.

Porter, C. W., Engr., Henry Bartlett, Orlando, Fla.

Sklarevski, Rimma, Jr. Sales Engr., American Radiator Co., Baltimore, Md.

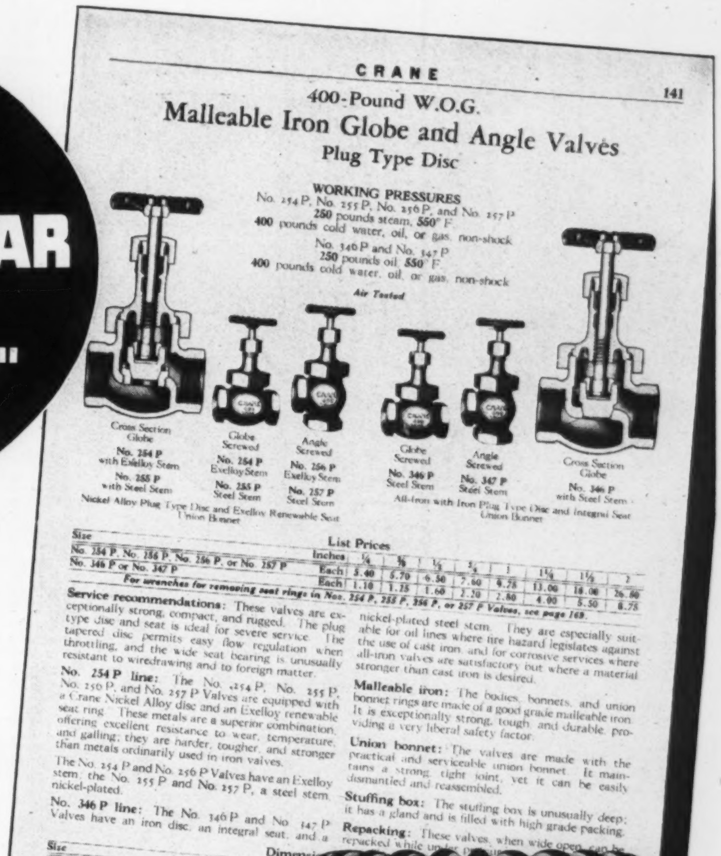
Sommerfield, S. S., Design Engr., Standard Galvanizing Co., Chicago, Ill.

Stevens, K. M., Sales Engr., The Powers Regulator Co., Kansas City, Mo.

STUDENTS

Danielson, L. C., University of Illinois, Urbana, Ill.

A GOOD VALVE FOR "WEAR AND TEAR Service"



CRANE

141

400-Pound W.O.G.
Malleable Iron Globe and Angle Valves
Plug Type Disc

WORKING PRESSURES
No. 254 P, No. 255 P, No. 256 P, and No. 257 P
250 pounds steam, 550° F
400 pounds cold water, oil, or gas, non-shock
No. 346 P and No. 347 P
250 pounds oil, 550° F
400 pounds cold water, oil, or gas, non-shock

Air Tested

Cross Section Globe
No. 254 P with Exelloy Stem
No. 255 P with Steel Stem

Globe Screwed
No. 254 P Exelloy Stem
No. 255 P Steel Stem

Angle Screwed
No. 256 P Exelloy Stem
No. 257 P Steel Stem

Nickel Alloy Plug Type Disc and Exelloy Renewable Seat
Union Bonnet

Globe Screwed
No. 346 P Steel Stem

Angle Screwed
No. 347 P Steel Stem

Cross Section Globe
No. 346 P with Steel Stem

All-Iron with Iron Plug Type Disc and Integral Seat
Union Bonnet

List Prices

Size	Inches	¼	⅜	½	¾	1	1¼	1½	2
No. 254 P, No. 255 P, No. 256 P, or No. 257 P	Each	5.40	5.70	6.50	7.60	9.75	13.00	18.00	26.80
No. 346 P or No. 347 P	Each	1.10	1.25	1.60	2.20	2.80	4.00	5.50	6.75

For wrenches for removing seat rings in Nos. 254 P, 255 P, 256 P, or 257 P Valves, see page 169.

Service recommendations: These valves are exceptionally strong, compact, and rugged. The plug type disc and seat is ideal for severe service. The tapered disc permits easy flow regulation when throttling, and the wide seat bearing is unusually resistant to wiredrawing and to foreign matter.

No. 254 P line: The No. 254 P, No. 255 P, No. 256 P, and No. 257 P Valves are equipped with a Crane Nickel Alloy disc and an Exelloy renewable seat ring. These metals are a superior combination, offering excellent resistance to wear, temperature, and galling; they are harder, tougher, and stronger than metals ordinarily used in iron valves.

The No. 254 P and No. 256 P Valves have an Exelloy stem; the No. 255 P and No. 257 P, a steel stem, nickel-plated.

No. 346 P line: The No. 346 P and No. 347 P Valves have an iron disc, an integral seat, and a nickel-plated steel stem. They are especially suitable for oil lines where fire hazard legislates against the use of cast iron, and for corrosive services where all-iron valves are satisfactory but where a material stronger than cast iron is desired.

Malleable iron: The bodies, bonnets, and union bonnet rings are made of a good grade malleable iron. It is exceptionally strong, tough, and durable, providing a very liberal safety factor.

Union bonnet: The valves are made with the practical and serviceable union bonnet. It maintains a strong, tight joint, yet it can be easily dismantled and reassembled.

Stuffing box: The stuffing box is unusually deep; it has a gland and is filled with high grade packing.

Repacking: These valves, when wide open, can be repacked while under

Size	Dimensions							
End to end, Globe	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Center to end, Angle	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Center to top of wheel, open, Globe or Angle	4⅜	4⅝	5⅛	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Diameter of wheel	1¾	2¹/₁₆	2⁹/₁₆	2⅞	[illegible]	3⅞	4³/₁₆	4¾

(Printed in U. S. A.)

CRANE
400
WOG

● For throttling, blow-off and other severe services, the Crane No. 254 P Malleable Iron Globe Valve will give your customers exceptionally good and dependable service with minimum maintenance. The hard seating metals used for the plug-type disc and renewable seat are a superior combination which offers excellent resistance to wear, temperature and galling, being tougher and stronger than metals ordinarily used in iron valves.

The plug disc permits easy flow regulation when throttling, and the wide seat bearing is unusually resistant to wiredrawing and to foreign matter. A practical, serviceable union bonnet maintains a strong, tight joint, yet can be easily dismantled or reassembled. An unusually deep stuffing box with gland and filled with high grade packing insures tightness around the stem. The valve, when wide open, can be repacked under pressure. Working pressures, 250 pounds steam, at 550°F., 400 pounds cold water, oil or gas, non-shock.

There's a Crane valve or fitting for every piping requirement. Each can be relied upon to give long, faithful service with minimum maintenance. The Crane branch or distributor in your vicinity can fill most needs from stock.

Crane valves, fittings, piping accessories and fabricated piping are fully described in the new No. 52 Catalog. The No. 254 P Globe Valve and its companion angle valve, No. 256 are described and listed on page 141.

Your customers' improvements can pay for themselves on the Crane Finance Plan.

CRANE

CRANE CO., GENERAL OFFICES: 836 SOUTH MICHIGAN AVENUE, CHICAGO, ILL. • NEW YORK: 23 W. 44TH STREET

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VALVES, FITTINGS, FABRICATED PIPE, PUMPS, HEATING AND PLUMBING MATERIAL

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Is your present equipment heating the entire working area satisfactorily and uniformly?

WING Floodlight PRINCIPLE OF HEATING

Offers you low cost heating plus a new mode of comfort. It spreads a uniform, healthful temperature over the entire working area. Send for interesting free booklet, "Wing Featherweight Unit Heaters".

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Check across the square — sign your name — and mail to us.

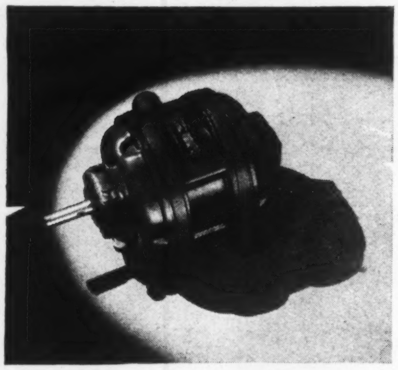
Equipment Developments

For your convenience in obtaining more information about any of this equipment, see coupon on page 126. Add the new products and companies listed here to your Directory Section which you received in your January 1936 HEATING, PIPING AND AIR CONDITIONING and thus keep your records of sources of supply up to date throughout the year . . . Single asterisk (*) indicates equipment not listed in Directory Section; double asterisk (**) equipment and manufacturer not listed.

Motors of New Design

No. 1072—A new design of riveted frame, squirrel cage, polyphase induction motors, in frame sizes of from 1 to 15 hp at 1,800 rpm, has recently been placed on the market; they are available in a variety of electrical and mechanical modifications, incorporate improvements in stator coil insulation, frame construction, and other design features.

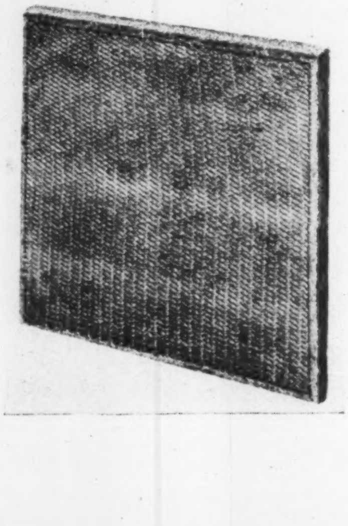
Co-ordination of design permits the different modifications of motors in the line to be used interchangeably for many types of power supplies and for various applications requiring open, sleeve- or ball-bearing, enclosed, enclosed fan cooled, splash proof, vertical motors, etc. As a result of this adaptability, many special requirements may be met with the standard available line.



A new insulation system "built from the inside out" is employed for the stator coil windings, which are of the random wound type, with joints at the connections fused instead of soldered. Recently developed insulating materials and processes are utilized, eliminating the need for taping the end windings and producing an insulation assembly which the maker states has high resistance to moisture and other common deleterious influences, such as mild acids, alkalies, oil and abrasion.

A new riveted frame construction and new end frames made of malleable iron, with integrally cast feet, contribute to strength and rigidity, providing increased resistance to vibrating and shock loads. Cast iron end shields maintain accurate bearing alignment and uniform air gap.

Convenience features include two part conduit boxes to provide ready access to leads and which can be mounted in any one of four positions; handy knock-off ledges on end shields to permit easy disassembly with ordinary tools; adequate wrench room for removing end-shield cap screws; ball bearings with pressure grease fitting and relief plug; sleeve bearings with oil filler gauge that can be placed on either side of housing, and general simplicity and accessibility of all parts.—General Electric Co., Schenectady, N. Y.



Washable Water-and Acid-Proof Filter

No. 1073—New "Permo Pad" air filter is washable, moisture proof and acid proof unit which is odorless, sterile and has an unusually large storage capacity, according to the maker.

FRETZ-MOON PIPE

..IS FREE
FROM
SCALE

It's made from clean material—specially-made skelp, as clean as it is possible to roll steel. It's made by a clean process—the exclusive "continuous process" in which the steel skelp is carried through the heating furnace high above the scale, slag and siliceous matter that accumulate on the floor of any furnace. • To further insure cleanliness, Fretz-Moon Pipe is passed through specially-designed rolls that break off all scale caused by heating. The scale is then washed out of the pipe by water under pressure. When galvanized, the pipe is blown clean with superheated steam. • You'll find Fretz-Moon Pipe clean and free from corrosion-promoting scale—with full capacity flow for air, gas or liquids. • If you want better, cleaner pipe without any increase in cost, use Fretz-Moon Pipe.

FRETZ-MOON TUBE CO., INC.
BUTLER • PENNA.

FRETZ-MOON
PIPE
BLACK AND GALVANIZED

REFRIGERATOR MAKERS REDUCE STEAM COSTS

Harder Corporation Uses 37 P. C. Less Coal After Modernizing Steam-Using Equipment

Hylo Steam Variator Control

Cobleskill, N. Y.—The improved performance resulting from a Webster heating modernization program recently completed in the buildings of the Harder Refrigerator Corporation has focused attention on the opportunities for economy in heating modernization of industrial plants.

The Harder Corporation Plant uses steam for several purposes, heating of office and shop buildings, dry kilns and glue pots.

Coal consumption has been reduced approximately 37 per cent as a result of the Webster heating modernization program. This savings figure is based upon a comparison of coal consumption before and after modernization, with correction for degree day differences. The actual fuel saving from December through May of the 1935-36 heating season was 327.97 tons of coal.

The modernization program was carefully planned by Webster engineers to meet the particular needs of the plant. Dry kilns were equipped with Webster Series "78" Traps and Webster Series "78" Dirt Strainers. Glue pots were equipped with Webster Series "78" Traps. Radiators were equipped with Webster Series "7" Radiator Traps and with new Webster Supply Valves.

The piping was re-graded and, where necessary, mains were equipped with Webster Drip Traps and Dirt Strainers. All radiators were equipped with Webster Metering Orifices to balance distribution. A Webster Oil Separator was also installed.

The direct radiation of the heating system was placed under Webster HYLO Steam Variator Control.

Mr. H. F. Ryder, Vice-President of the Harder Refrigerator Corporation, had this to say about the improved system:

"We knew from our own records that we were burning far less coal than last year. On the basis of degree days, the saving in coal consumption was 37%.

"The saving in the cost of coal is not the only benefit we have received, for we have had better distribution of heat, less trouble with the heating system and of course the firing of the boilers has been much less strenuous. During 1934-35, we kept our two boilers running almost continuously through the winter, whereas this season we have had to operate only one except in a very short extreme period."

Webster Service, a part of every Webster System, is valued highly by owners, architects and heating contractors. Traps, valves, orifices, concealed radiation, central heat controls—all are available from one manufacturer under undivided responsibility.

If you are interested in heating *new* buildings, or in improved heating service and lower heating cost in your present building, address

Warren Webster & Company . . . Camden, N. J.
Pioneers of the Vacuum System of Steam Heating
Branches in 60 principal U. S. Cities . . . Darling Bros., Ltd., Montreal, Canada

Here's where
COLD LINE LOSSES
STOP

...And Air Conditioning efficiency **BEGINS!**

NOVOID Cork Covering gives lasting protection to cold water risers and attendant piping for air-conditioning systems, and helps assure accurate temperature control. As a result, it provides a permanent check against costly cold line losses.

Thanks to its natural cell structure, Novoid Cork Covering forms a positive barrier to the passage of heat, and ably resists the damaging effects of moisture. Each section is carefully machined to fit pipes snugly and eliminate moisture-catching air pockets. And as a further seal against air and moisture, the sections are finished with a coating of mastic asphalt.

Novoid Cork Covering is easily and quickly installed, and is delivered ready to fit metal pipe and welding ells. For complete information, get in touch with our nearest branch or write Cork Import Corporation, 330 West 42nd Street, New York City.

BRANCH OFFICES: Chicago — 400 W. Madison Street. Boston—27 Haymarket Square. Philadelphia—1524 Chestnut St.

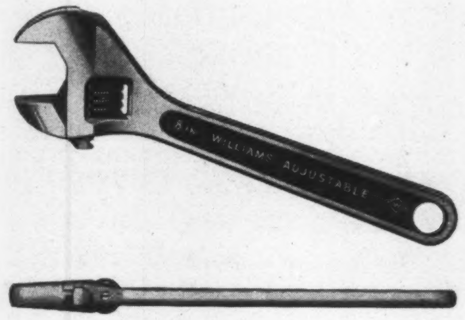
NOVOID *cork pipe* COVERING

It is progressively packed, the media being loosely formed on the entering air face and densely packed on the exit side. Sold as a replacement filter it can be re-used many times, as it is readily cleaned either by beating or by washing in hot water, steam or naphtha. Unit is self-supporting, and has a flexible edge all around the pad to prevent leakage.

Standard sizes range from 10x10x2 to 20x30x2 in., with capacities from 200 to 1200 cfm. Initial resistance of a single pad is 0.09 W.G. For commercial installations standard ladder type frame units with two pads in each frame are furnished, overall dimensions being 20x20x6 in. These can be arranged in either straight or "V" type formation.—Independent Air Filter Co., 215 W. Ohio St., Chicago, Ill.

New Adjustable Wrenches

No. 1074—Two new lines of adjustable wrenches embody new design features, including square shoulders on the movable jaw shank said to overcome wedging and spreading action and to provide a positive bearing against working stress. Design permits thicker and stronger "web" without increasing total head thickness of wrench.



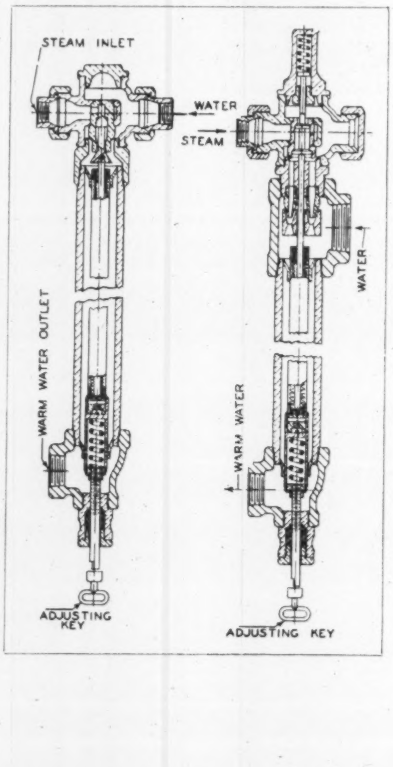
The "Adjustable" wrenches drop forged from a special carbon steel, are supplied in a natural polished steel finish. The "Superjustable" wrenches, forged from chrome alloy steel, are finished in chrome-plate with highly polished heads and satin finish handles.

Both lines available in five sizes—4, 6, 8, 10 and 12 in.—J. H. Williams & Co., 75 Spring St., New York, N. Y.

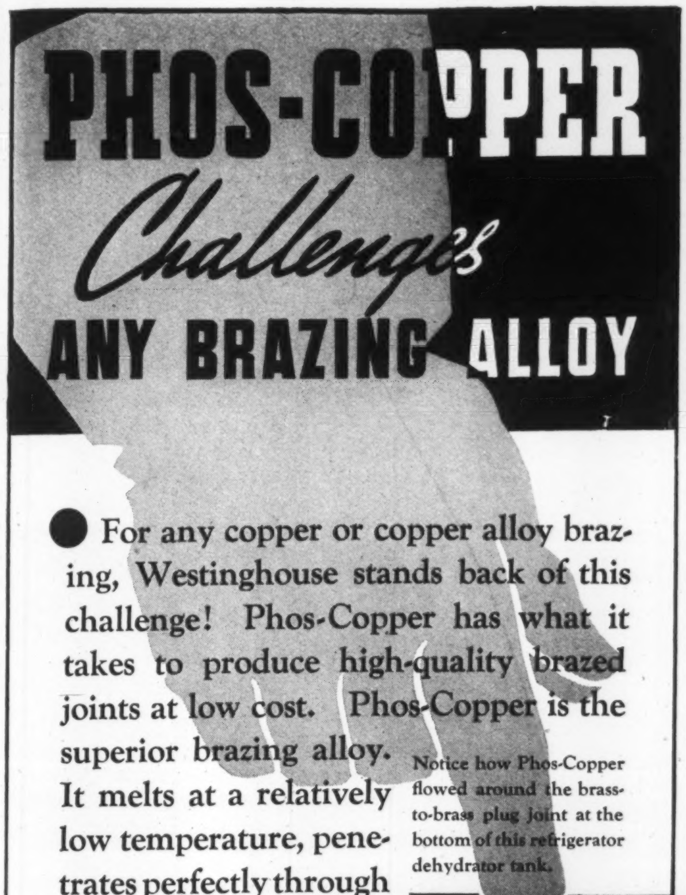
New Steam and Water Mixer

No. 1075—Recently announced steam and water mixer, available in two sizes, is a compact and self operated mixing valve which produces hot water at any desired temperature automatically at the point of use by mixing steam and water in the required proportions. The mixer incorporates a three way valve, a water injector and a temperature regulator in one unit.

Nozzle type injectors are used to insure silent operation. Small sizes use single seated valves and large sizes, double seated. Particularly applicable in industries where hot water at different temperatures is required by different departments; frequently



PHOS-COPPER *Challenges* ANY BRAZING ALLOY



● For any copper or copper alloy brazing, Westinghouse stands back of this challenge! Phos-Copper has what it takes to produce high-quality brazed joints at low cost. Phos-Copper is the superior brazing alloy. It melts at a relatively low temperature, penetrates perfectly through tight joints, requires no flux on most applications, resists corrosion, possesses high ductility, high tensile strength and high fatigue resistance, and is economical and easy to use—characteristics that mean better joints at lower cost.

Notice how Phos-Copper flowed around the brass-to-brass plug joint at the bottom of this refrigerator dehydrator tank.

J 20110

Try PHOS-COPPER AT OUR EXPENSE

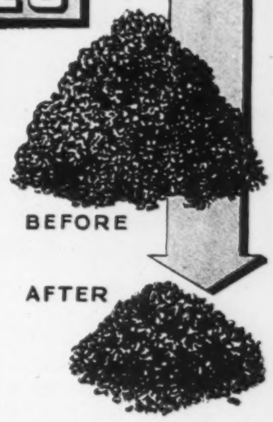
PHOS-COPPER
LOW COST HIGH QUALITY BRAZING ON COPPER, BRASS AND BRONZE

WRITE FOR A TRIAL SAMPLE. We will also send you, without obligation, a copy of Booklet 2076 which contains technical and test data on Phos-Copper. Address Room 5-N, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

WESTINGHOUSE 1886 1936 GOLDEN JUBILEE

Westinghouse

Coal Bills Go Down When SARCO Goes In!



Keep condensate out of your radiators and you will greatly increase the heating efficiency of all the fuel consumed.

Sarco Radiator Traps automatically expel condensation without the loss of any of the heating medium.

They prevent noisy, air-bound, water-hammering radiators and insure maximum heating all the time.

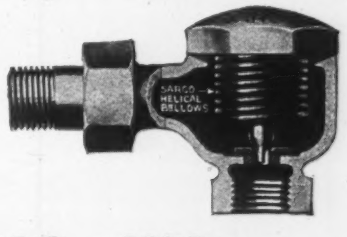
SARCO RADIATOR TRAPS

are quality traps through and through. The body is non-corrosive cast bronze, nickel finished with polished trimmings.

Bellows is made of heavy seamless helically corrugated tubing. Valve heads are self-aligning. Traps are noiseless and economical in operation.

Write for our interesting catalog O-45.

SEE OUR EXHIBIT AT BOOTH No. 81
Twelfth National Exposition of Power & Mechanical Engineering, Grand Central Palace, New York, Nov. 30 to Dec. 5, 1936.



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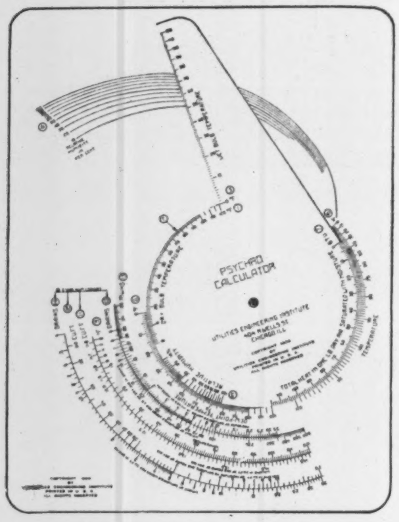
183 MADISON AVE., NEW YORK, N. Y.
Branches in Principal Cities
Sarco Canada Limited, Federal Building, Toronto, Ontario, Canada



they make unnecessary the use of a separate small water heater. — Sarco Co., Inc., 183 Madison Ave., New York, N. Y.

Calculator for Psychrometric Problems

No. 1076—Recently developed "psychro-calculator" has been designed to be used in determining psychrometric values and properties of air and water vapor mixtures. By one setting of the movable indicator, any two of the four psychrometric values (dew point, dry bulb, wet bulb and relative humidity) may be obtained if the other two are known.

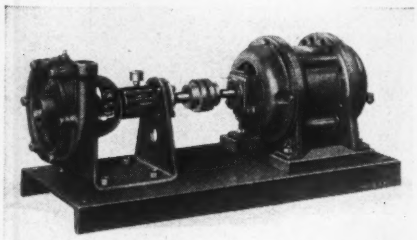
In addition to serving the purpose of the psychrometric chart, the calculator will give such values as weight of saturated vapor per lb of dry air in grains; vapor pressure in inches of Hg. and weight of saturated vapor per cu ft in grains by reading direct from the dew point temperature. Values found from the wet bulb temperature are total heat in Btu per lb of dry air with vapor to saturate and the difference in total heat of any two wet bulb temperatures. Values that may be read directly from the dry bulb are volume in cu ft of 1 lb of dry air, without any adjustment, and the volume of moisture to saturate one lb of dry air. Any partially saturated mixture from 0 to 120 F may be evaluated.

Instructions for the settings are printed on the reverse side. Can be read to two or three significant figures, depending upon the location on the scales. Based upon standard barometric pressure.

The calculator is $7\frac{1}{2}$x$10\frac{1}{2}$ in. and is cleanable.—Utilities Engineering Institute, 404 N. Wells St., Chicago, Ill.

Small Centrifugal Pumps

No. 1077—A small, low cost centrifugal pump recently announced features simplicity of design, few wearing parts, compactness and low maintenance costs. Furnished with direct motor drives or with pulley for belt drives, the motor sizes range from $\frac{1}{3}$ to 3 hp, capacities 10 to 130 gpm, heads 10 to 100 ft.

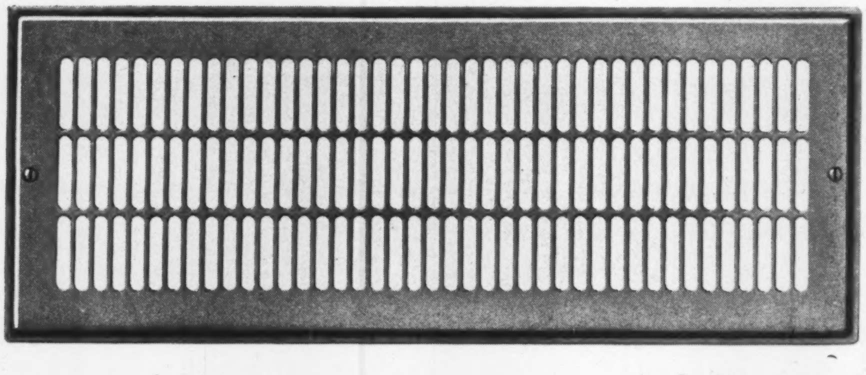


Shaft is supported by two ball bearings enclosed in dirt- and moisture-proof housing. Suction head easily removable for inspection of interior. Standard, all iron, and all bronze fittings are available.—Worthington Pump & Machinery Corp., Roosevelt Ave., Harrison, N. J.

Supported Furnace Wall

No. 1078*—New design of supported furnace wall was developed with following principles in mind: Wall is sectionalized,

AUER
Registers
Are Preferred by Practical Air Conditioning Men



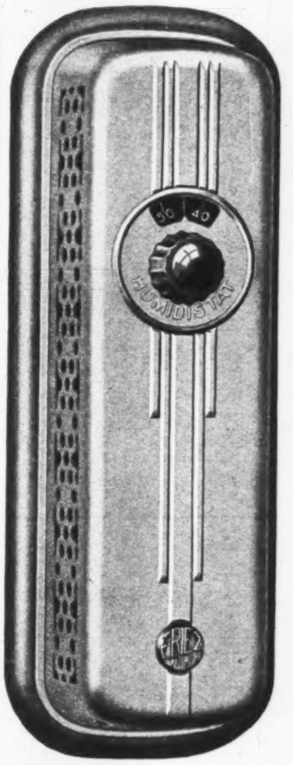
Profit by the experiences of others. By standardizing on AUER Registers, Cold Air Faces, and Grilles, you make every heating or air conditioning job you handle just that much easier. Every PRACTICAL feature for strength, efficiency, and ease of installation has been incorporated in these registers. Directional air-flow registers have either FIXED or MOVABLE blades, as desired. The AUER CLASSIC design is preferred by many leading architects and contractors—but AUER has a type and style for EVERY requirement.

● The famous AUER CLASSIC face (shown above) is a design of character and restraint, in good taste in the finest of modern interiors. Write for Air Conditioning Register Catalog 36A ●

THE AUER REGISTER COMPANY, 3608 PAYNE AVENUE, CLEVELAND, OHIO

AUER DISTINCTIVE REGISTERS
& GRILLES For Air Conditioning *and* Gravity

HUMIDITY WINTER HEATING



Satisfied customers have made the Friez Humidistat the nonpareil in all humidity control . . . either for comfort or industry. The pioneer human hair elemented instrument, its four years of life sees it now as the only reliable type in demand. Standard fitment with most leading builders of air-conditioning equipment, it will serve you well. You can be sure of hair-trigger control for either high or low points of humidity.

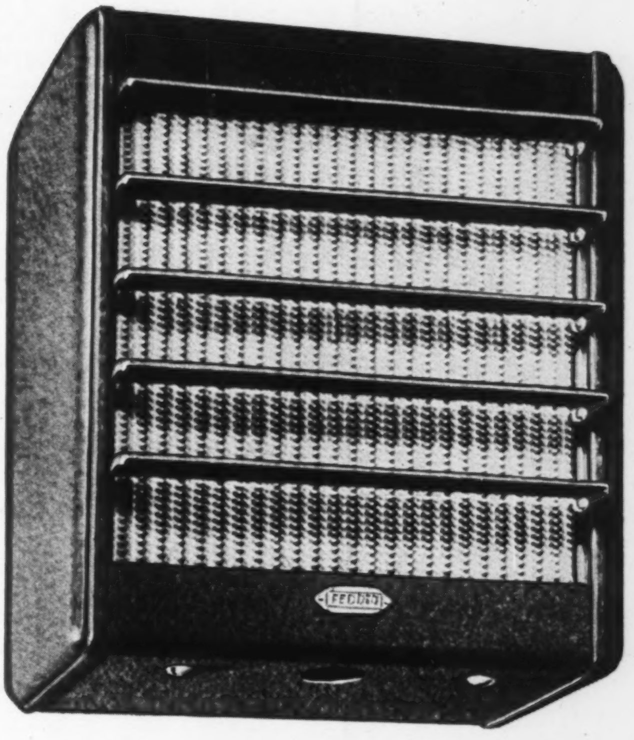
FOR HUMIDITY CONTROL IN WINTER HEATING — ONLY ONE STANDS OUT — THE FRIEZ HUMIDISTAT.

30 40 50
80 90
HUMIDISTAT

Now for insertion in return-air ducts, and for numerous industrial purposes the same reliable functioning is assured in a mounting exactly adapted for these special needs.

Write for Bulletin

JULIEN P. FRIEZ & SONS, Inc.
"The Makers of America's Weather Instruments"
BALTIMORE MARYLAND



Why **FEDDERS** UNIT HEATERS *Can't Commit Suicide*

Severe expansion stresses due to sudden wide temperature changes are the greatest source of self-destruction in unit heaters. Full-Floating element mountings allow Fedders heating elements to expand and contract within the cabinets.

Fedders 3 to 1 streamline tubes and individual convoluted fins eliminate expansion stresses between neighboring tubes. Each tube is free to "give" laterally and independently rather than being tied to all adjacent tubes from top to bottom.

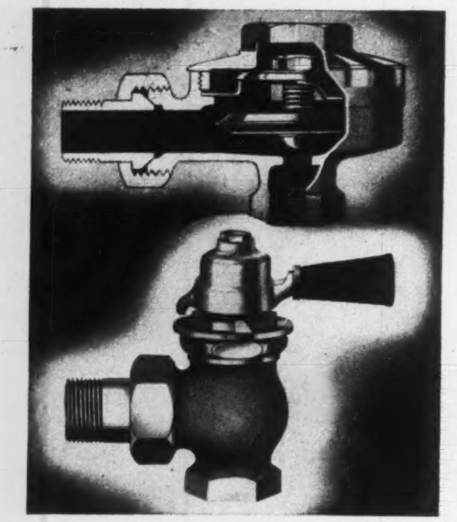
Sturdy electrically welded monopiece steel cabinets protect the heating element from piping strains.

Fedders handsome appearance and quieter operation now make the high heating efficiency of unit heaters available to commercial as well as industrial applications.

Catalog 542 shows why Fedders Unit Heaters can't commit suicide,—write for your copy right now.

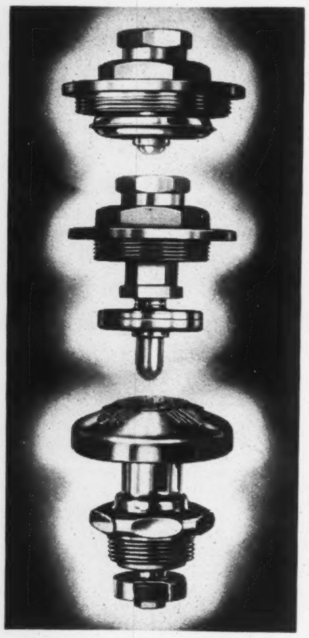
Are You Getting Your Copy of the Fedders News?

FEDDERS
MANUFACTURING COMPANY
BUFFALO, N. Y.



MILVACO
HEATING SPECIALTIES
ARE
dependable!

The service records of MILVACO heating installations are proof of the greater dependability of MILVACO Heating Specialties. No matter how exacting the demands made upon them they are equal to every service requirement for which they are recommended.



In design and construction every MILVACO product reflects the engineering research and precision methods of manufacture involved in its production. These are factors which insure higher operating efficiency and longer, low cost service.

MILVACO SPECIALIZED MODERNIZATION UNITS

For economy, efficiency and ease of installation use MILVACO Modernization Units.

There is a MILVACO thermostatic trap adaptor and radiator valve bonnet replacement assembly to fit every popular make thermostatic trap and radiator valve in use today.

Send for folder "H" which gives full particulars.

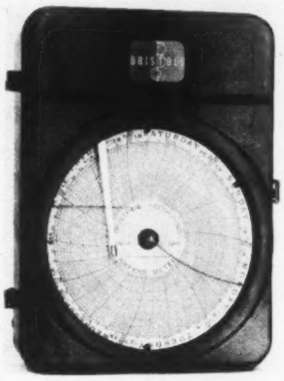
MILWAUKEE VALVE COMPANY
MILWAUKEE Manufacturers of WISCONSIN
MILVACO Heating Specialties and APPROVED Bronze Valves

each section being built independent of any other; weight of refractory is transferred to supporting steel framework; all supporting metal is entirely in back of the refractory where it can be cooled by circulating air; joints broken to prevent infiltration of air into furnace.

Spacing of the refractory belts can be varied by increasing or decreasing the number of courses of standard fire brick, which reduces the number of casting and tile shapes required.—Geo. P. Reintjes Co., 2517 Jefferson St., Kansas City, Mo.

Recording Voltmeters and Ammeters

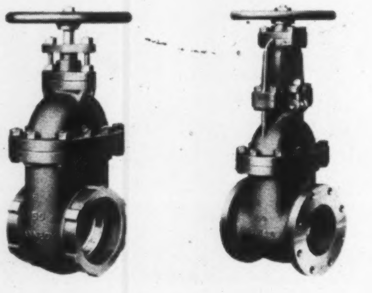
No. 1079—New line of round chart recording voltmeters and ammeters for industrial and electric utility service are offered in wall, switchboard, flush panel, and pole mounting, and for portable use. They are housed in moisture-, fume- and dust-proof case of aluminum alloy. The measuring element is a separate unit that can be easily replaced.



These recorders are offered with spring driven and electric "Telechron" clocks.—The Bristol Co., Waterbury, Connecticut.

Standard Iron Body Wedge Gate Valves

No. 1080—A number of features are included in new line of standard iron body wedge gate valves, according to the manufacturer, who states that the metal is of a particularly dense structure, 50 per cent stronger than ordinary cast iron. To further insure strength and rigidity, the bodies are of oval section with rounded corners, heavy flanges and bolts are used, and ribbing is provided at the flanges on the larger flanged-end valves and at the yokes and caps of outside screw and yoke valves.

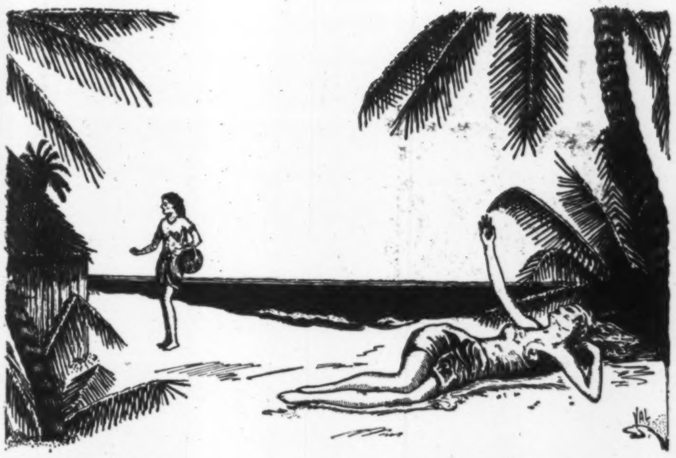


There are no studs at any part of the valves, and all bolts have the nuts above the flanges with ample room for standard open-end wrenches. An additional convenience feature on both the non-rising stem and outside screw and yoke types is special provision to facilitate repacking.

Other features include heavy bronze bushings wherever stem passes through a cast iron part to prevent erosion and scoring of stem, round ends on screwed-end valves for best distribution of the metal, and lugs for convenient application of pipe or chain wrench.

The discs, self-draining in any position, are reinforced with interior posts and are reversible and interchangeable. Special provisions are made to keep the stem in alignment.

Available in all standard sizes from 1½ to 60 in., steam working pressures at 150 lb and water working pressures at 200 lb.—Kennedy Valve Mfg. Co., Elmira, N. Y.



BVD's for BTU's?

WHAT—no asbestos suits for these beauties? No, we don't sell much Ric-wiL in the South Seas. For the famed Virgins of Bali, for the delectable damsels of Tahiti, protective covering is not needed. In fact, to obscure such *lines* as these would be a mistake.

It's another story with *steam lines* underground. Here protection is an absolute necessity. But unless you have insulation that *insulates,* and drainage that *drains,* unless you have *sealed-in* steam—your steam lines might almost as well "go nudist." You can't make B V D's take the place of ulsters. This year, as every year, correctly dressed steam lines are wearing Ric-wiL.

26 years' experience gives the Ric-wiL Organization an invaluable advantage. Ric-wiL Systems are correctly engineered and drained—they keep steam lines tight, dry and over 90% efficient. Designs and materials in both tile and cast iron to meet all possible conditions. Obtainable with various insulations, including the famous Ric-wiL Watertight Asbestos Dry-paC. Ric-wiL service is complete from coast to coast—installation, engineering, field supervision. Write for complete catalog, with Dry-paC sample for testing.

The Ric-wiL Co., Union Trust Bldg., Cleveland, Ohio
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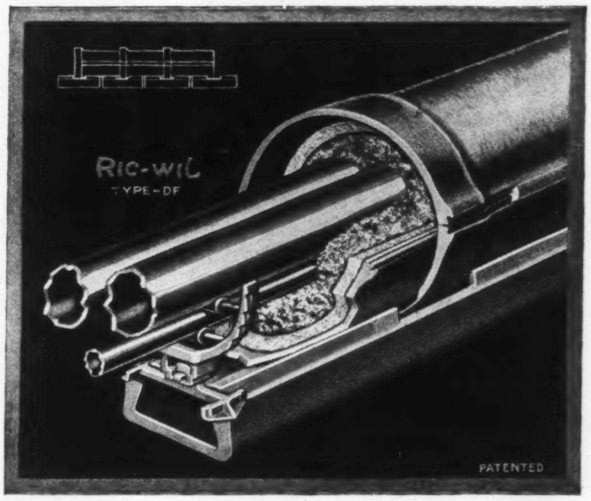
Heat loss from conduit in wet soil is over four times that in dry soil. Ric-wiL External Underdrain keeps the soil DRY.



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RIC-WIL

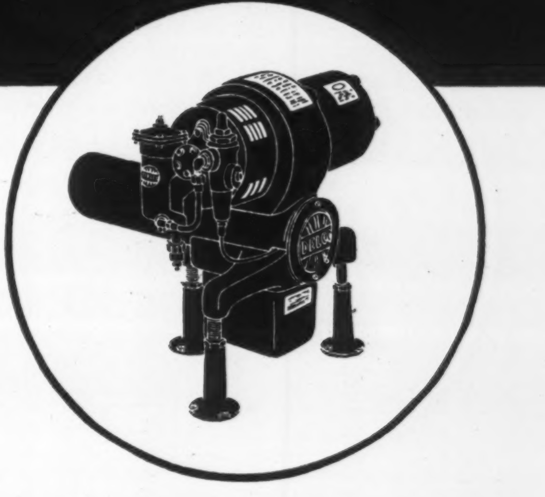
CONDUIT SYSTEMS FOR UNDERGROUND STEAM PIPES

Delco-Heat

with the

"THIN-MIX" Fuel Control

Steps Ahead



Today Delco-Heat is the fastest selling oil burner on the market

THIS LEADERSHIP is of importance to everyone interested in the sale and installation of automatic heating equipment.

Delco-Heat, a product of General Motors, offers definite economy advantages with its famous "Thin-Mix" Fuel Control, and other exclusive features.

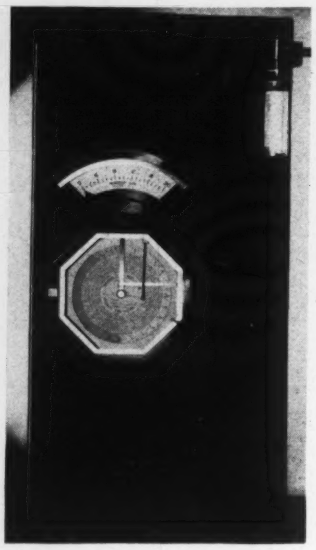
Delco-Heat is telling the public about these definite reasons for selecting automatic heating products of General Motors.

These are just a few of the reasons why Delco-Heat is the fastest-selling oil burner on the market.

DELCO-FRIGIDAIRE
CONDITIONING CORPORATION
AUTOMATIC HEATING **DAYTON, OHIO** *AIR CONDITIONING*
A PRODUCT OF GENERAL MOTORS

Redesigned CO_2 Meter

No. 1082—Redesigned motor driven CO_2 meter is of the mechanical indicating and recording type, registering a continuous pen line record of per cent CO_2 in the flue gas, measured by the Orsat method. If desired, two additional records can be placed on the same 10 in. chart and these records may be any combination of draft, temperature or flow measurement.



According to the manufacturer, the meter has been ruggedly built for years of continuous service, and the entire mechanism is protected by a steel cover completely enclosing the back of the panel. The potash chamber is of sufficient size to hold a 6 months' supply of the solution, and all conductor tubes submerged in this solution are of stainless steel to prevent corrosion.

Available in four types, each of which is mounted on a 12 ga steel panel 40 by 16 in. The principle of operation is completely described in a recently issued bulletin.—Republic Flow Meters Co., 2240 Diversey Pkwy., Chicago, Ill.

Small Inverted Bucket Trap

No. 1083—New "Super-Silvertop" inverted bucket trap with height of only 4 in. is particularly recommended by the manufacturer for use on radiators, unit heaters, coffee urns, steam tables, sterilizing equipment, clothing presses, laundry machinery and at drip points on steam mains.

SUPER-SILVERTOP

Valve and seat are made of "Anderloy," a chrome alloy. Bucket is of one-piece copper, and working parts are stainless steel. Bucket is guided by a hexagonal tube and, states the maker, does not leak steam, hence it operates on vacuum. Pipe connections are like those on thermostatic traps, permitting replacement without changing the piping. May be fitted with thermal air eliminator.

No strainer is used, as the trap is designed to handle ordinary dirt and scale.—V. D. Anderson Co., 1949 W. 96th St., Cleveland, O.

New Device for Draftless Air Distribution

No. 1084**—The "Anemostat" air distributor is designed to solve the problem of draftless air distribution by reducing the speed of air flow to such an extent that it is no longer perceptible as a draft, without reducing the volume of air. According to the manufacturer, by means of the "Anemostat" the velocity of an air current entering a room can be reduced to 1/20; the apparatus can be designed to give any desired velocity in any direction, and an intimate mixing effect is achieved of the incoming air with the air already in the room. In addition, it does not in itself create noise; its resistance equals a 90 deg smooth bend.

Among the various applications are: (1) Air diffusion in connection with ventilation, air heating and cooling; (2) in combination with large standing fans and small fans of the non-oscillating type; (3) in combination with air conditioning units using shut-

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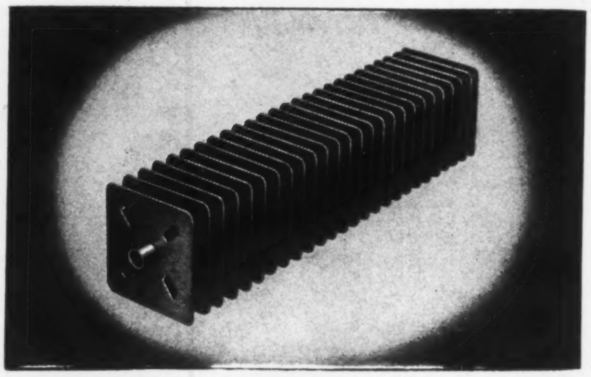
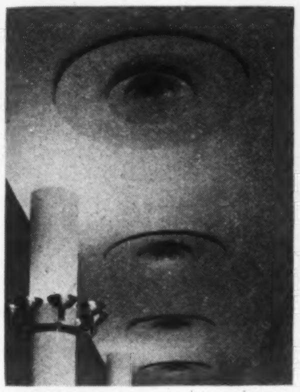
The Golf-Pro thru constant practice develops a technique, so have we by our constant practice in one line of manufacture only, developed a technique that allows us to serve you more efficiently.

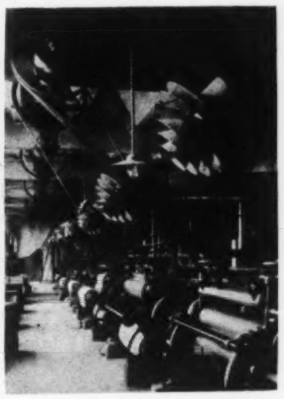


There are now 38 combinations of fin and tube sizes and fin spacings in our standard line of finned tubing.

THE BUSH MFG. CO., HARTFORD, CONN.
BRANCH FACTORY 610 N. OAKLEY BLVD., CHICAGO, ILLINOIS
BRANCH OFFICES: NEW YORK, DETROIT, CHICAGO, DAYTON, CLEVELAND, PHILADELPHIA AND LOS ANGELES

ter arrangements; (4) in combination with individual heating units for factories; (5) for the purpose of dust laying and collecting in asbestos, talc, rubber and vulcanizing plants, etc.; (6) for the purpose of smoke reduction by placing "Anemostat" arrangements between boiler and smoke stack; (7) for the even distribution of hot air in industrial furnaces; (8) gas diffusion in chemical processes; (9) ventilation of telephone booths, aircraft, railway carriages, motor busses, automobiles, cabins and engine rooms on ships and tunnels; (10) flame destroyer.



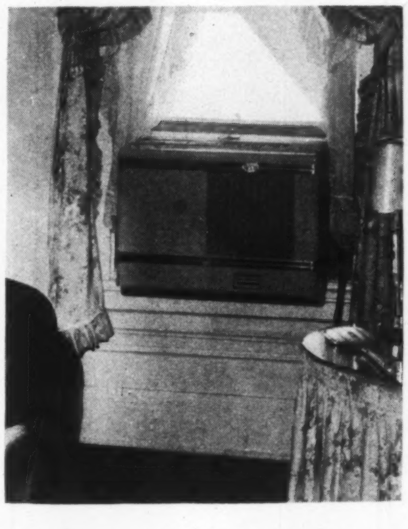


The three standard types include Type A for air velocities up to 5,000 fpm, Type B for velocities up to 4,000 fpm, and Type C for velocities up to 2,500 fpm. The standard unit consists of several hollow flaring members placed in a certain relationship within or in front of each other, and can be combined with lighting fixtures.

"Anemostats" are installed at the New York Curb Exchange, and in the engine room of the "Queen Mary."—Anemostat Corp., of America, 551 Fifth Ave., New York, N. Y.

Window Cooling Unit

No. 1085—"Adco Aeriet" window cooling unit is an air cooled portable unit for window or floor use, which may be plugged into a wall electrical outlet, and is rated at ½ ton cooling capacity. No plumbing connections are required. Is recommended by the manufacturer for rooms of 1600 to 2000 cu ft.



Major parts of the unit include ½ hp motor, "V-8" compressor, expansion coil, rotary type air impeller, 1/20 hp motor with fan for dissipating compressor and motor heat, condenser coil, heat exhaust vent grilles, removable filtering element, high pressure cut-out and motor overload protection switch with dual selector, to permit ventilation only when cooling is not required. — Air Devices Corp., 210 S. Clark St., Chicago, Ill.

Air Operated Temperature Control

No. 1086—New "H & B All Range" temperature controller, total range of which extends from -100 F to 900 F, obtains the desired working range by a resetting screw which determines its mid-point, and a sensitivity instrument which determines its width. Stem is of "KA-2" alloy, of which the total expansion is used, and for best results, full length of stem should be ex-

REFRIGERANT CONTROL VALVE

SIMPLE
POSITIVE
LOW POWER CONSUMPTION

The popular trend toward A-P Controls is but a reflection of the super features that have made them supreme in the field.

Designed to insure against leakage past the valve. Simple and positive in operation against high pressures, and functions perfectly with very low power consumption.

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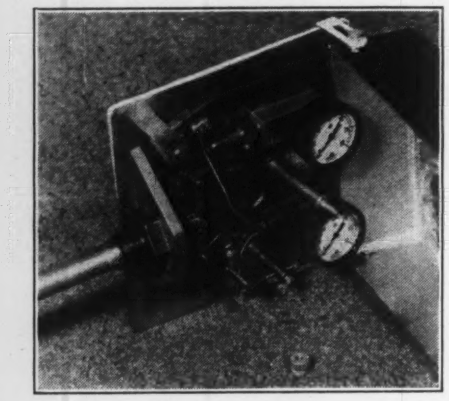
posed to temperature to be controlled. Operating medium is clean air or gas at 15 lb per sq in. constant pressure, quantity required for operation of diaphragm motor valve being less than 8 cu ft per hr.



One feature is a "throttling needle," whereby the conventional flapper is modified into a slow bleed device, which, in connection with the lever length adjustments, makes possible the regulation of speed of operation of diaphragm motor valve. Safety provisions prevent damage to controller parts in event of large sudden temperature change at stem.—B. O. Bushnell, 520 Anderson St., Los Angeles, Calif.

New Thermal Release for Motors

No. 1087—Because the National Board of Fire Underwriters has written its National Electric Code to specify a more rigid protection specification, a new cutout switch has been developed for motors in ratings of 1/8 to 1 hp used on appliances which start and stop automatically, and which is used to prevent burning out by cutting out motor in time, should current input at time of starting be too heavy, or should motor develop a serious overheated condition.

Device is trip-free and is so designed that it must be reset by hand. It sets silently by until the motor is so mistreated that it is called upon to act, and while it should not be used as the excuse for placing motors on applications which are unreasonable, it should be the deciding factor in border-line cases, says the maker.—The Leland Electric Co., 1501 Webster St., Dayton, O.

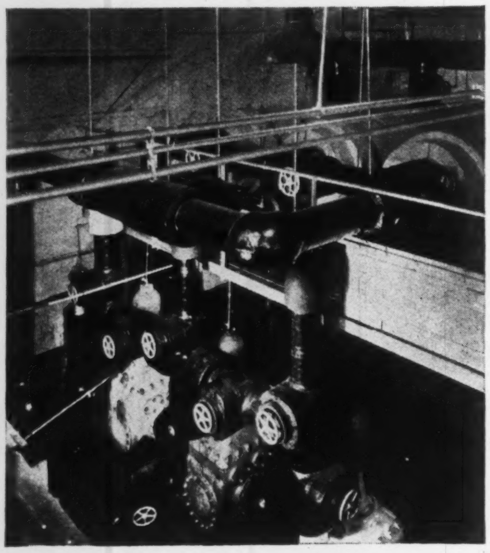
Automatic Flue Gas Analyzer

No. 1088—New automatic Orsat for analyzing flue gas samples ("Orsatomat") is of particular interest to heating contractors, as it enables scientific check of installations without special skill or training. According to the manufacturer, a sample of flue gas can be analyzed in 20 seconds simply by operation of a lever, results being indicated by pointer movement on a scale.

HAYS
ORSATOMAT
THE AUTOMATIC ORSAT
GAS ANALYZER
0
5
10
15
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
INCHES WATER

The instrument consists of a rotatable analyzing body which contains the measuring and absorption chambers, and is charged with mercury and an absorbing chemical; bellows and linkage for moving the pointer; an aspirator bulb and the necessary rubber tubing; and a pressed steel case with carrying handle.

Available for CO_2 and also in a twin unit for both CO_2 and O_2.—The Hays Corp., E. 8th St., Michigan City, Ind.



Even your closest personal inspection of this installation could not possibly convey the EASE with which Corinco Cork Pipe Covering can be applied.

This simplicity of application is facilitated by an ample supply of the accessories necessary to the proper erection and finishing of each job; waterproof cement, copper-clad annealed steel wire, brine putty, seam filler and covering paint; products specially manufactured and adapted to the high standards of Corinco Cork Pipe Covering.

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MANUFACTURERS OF CORINCO SHEET CORK • CORINCO GRANULATED CORK • CORINCO CORK PIPE COVERING

Air Filter Panels Developed

No. 1089**—Features of two types of "Air Maze" air filter panels recently developed include the following, according to the maker: They are easily cleaned, have about twice the ordinary service period between required cleaning, cause no undue restriction, filtering efficiency tests 98.5 to 99.03, and it is impossible for filter media to be shaken out of place by vibrations.

Stock sizes are 2 and 4 in. thick in 10x20 in., 20x20 in., and 16x25 in. sizes; recommended rated capacity is 2 cu ft per sq in. —Air-Maze Corp., Caxton Bldg., Cleveland, O.

Balancer for One-Pipe Steam Jobs

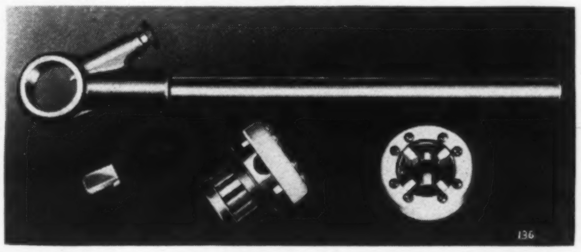
No. 1090—When combined with "Vent-Rite No. 2" vacuum valves, new "Vent-Rite" balancer creates the "Vent-Vac" system, for installation on automatically fired one-pipe steam jobs, so that all radiators will be heated at the same time; operates as an open atmospheric and vacuum system combined.

The balancer is a solenoid operated valve, which automatically returns a system under vacuum to atmospheric pressure at the start of every firing cycle, to meet the requirements of venting, intake, thermostatic closing and float seal action. The "Vent-Rite" valves are take-apart construction, and have tamper-proof adjustment.

Bases are brass drop forgings, valve pins are nickel silver, and finish is chromium plate (except convector valves, which are nickel plated). Electrical connection is made by connecting but two wires, and bottom outlet is ¾ in.—Anderson Products, Inc., Cambridge, Mass.

Ratchet Threader New Addition to Tool Line

No. 1091—Among the advantages featured in new ratchet threader are oil holes in the die heads for easy oiling and chip clearance, dies square in shape with no breakable offsets, dies can be inverted for threading close to walls and dies can be easily removed for resharpening, according to the maker.



This "No. 2 Beaver" is available in right or left hand; American Briggs or British Whitworth Standard; straight thread American conduit dies ½ and ¾ in.; Boston brass tubing, ¾ in. O. D. 20 thd; adjustable bolt dies and dieheads, ¼ to 1 in. by 16ths, U.S.S. or S.A.E.

Tool is made of unbreakable air furnace malleable iron, the finish is rust-proof and vanadium alloy steel dies are used.—Beaver Pipe Tools, Inc., 310 Dana, N.E., Warren, O.

New Flashlight Screw Driver

No. 1092—New flashlight screw driver will be found handy by the mechanic whose work requires the servicing of automobiles, oil burners, electric refrigerators, etc. Ample light is provided by switching on the light in the handle, which is of transparent, amber-colored, non-conducting composition material containing two standard flashlight batteries and bulb.

Blade is 3/16 in. in diameter with 3/16 in. tip, is 5 in. long, and is made of fine quality screw driver steel. Tip is machine-ground and magnetized for picking up small objects. Length overall is 10½ in.—Bonney Forge & Tool Works, Tilghman & Meadow Sts., Allentown, Pa.

Vilter
VERTICAL
COMPRESSO

for
"FREON"

Outstanding in the field of industrial compressors for modern air conditioning applications where "Freon" is used as the refrigerant is this Vilter Vertical Freon Compressor.

The compact size and proportions of this unit make it ideal for installations where floor space and head room are a factor.

The long years of successful experience in the field of refrigeration and cooling equips this company to render unusual service in handling individually-engineered projects.

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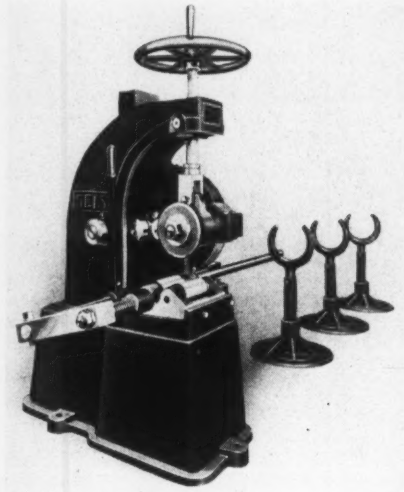
H. W. PORTER & CO., INC.
825 FRELINGHUYSEN AVE., NEWARK, N. J.

Improved Roller Pipe Cutter

No. 1093—The shaft which carries the disc cutter of the "No. 4 Geist" roller pipe cutter is now being mounted in roller bearings instead of bronze bushed bearings as heretofore, for stronger construction, longer life, and eliminating the need for making frequent adjustments to compensate for wear. Added rigidity of this mounting and precise alignment obtained between cutter shaft and rollers minimizes cutting off time, reduces burr thrown up on the pipe and increases life of the disc cutter, states the maker.



Capacity for cutting off pipe within a range of ¼ in. to 4 in. inclusive.—Landis Machine Co., Inc., Waynesboro, Pa.

International Refrigeration Congress Abstracts

The following abstracts of papers presented at the *7th International Congress of Refrigeration*, which met in Holland last June, are reprinted from a special issue of the *Bulletin* of the *International Institute of Refrigeration* by permission of the publisher.

The maximum rate of heat transfer with minimum loss of energy. Z. Nagaoka and A. Watanabe, Institute of Physical and Chemical Research, Tokio.

To promote the rate of heat transfer between the pipe wall and the liquid flowing in it, and to save the power necessary for the heat transfer, the authors have tried the following devices as turbulent promotor or retarder:

(1) Putting a guide vane in the pipe to give the liquid spiral motion.

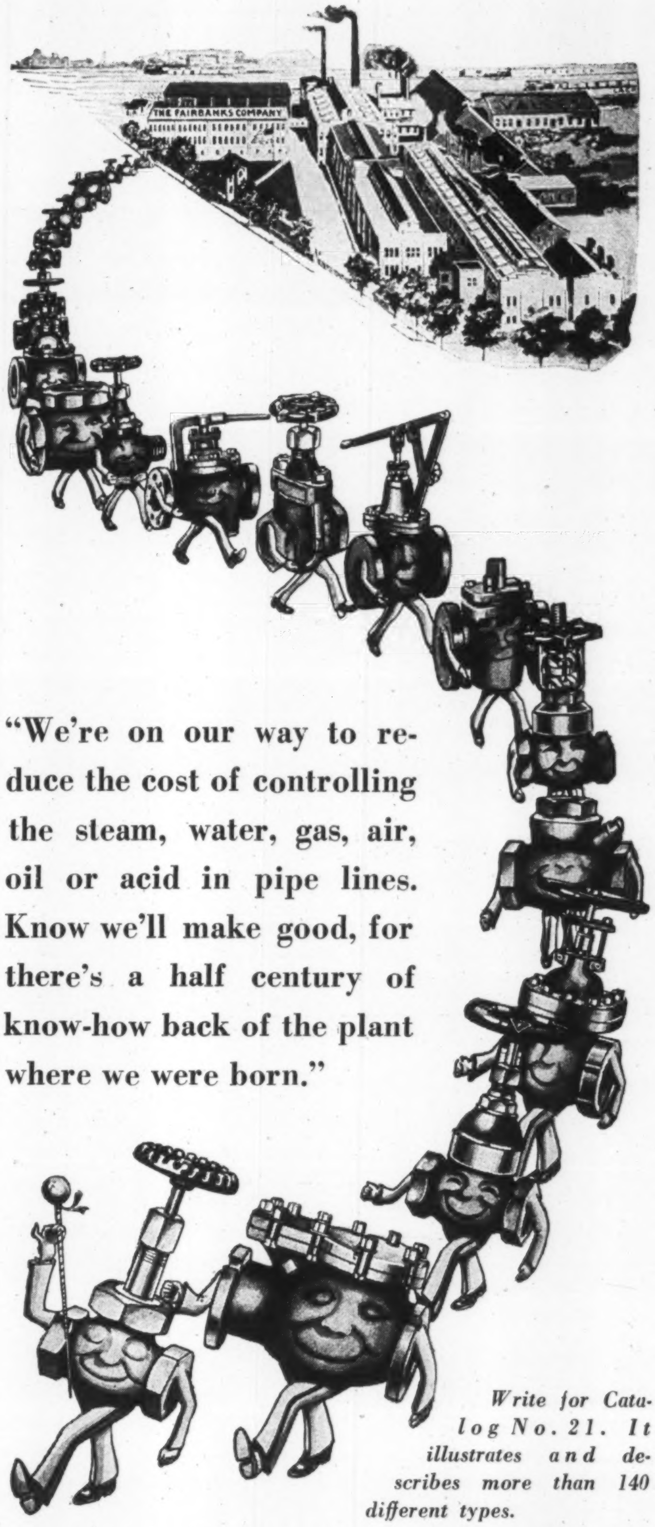
(2) Inserting a helical coil of wire of a small diameter, which is wound in a circle or a polygon, and touches the pipe wall, in order to disturb the laminar flow layer next to the pipe wall.

The water flowed through the pipe of 27 mm inside diameter, heated from outside by hot transformer oil. The flow velocity of water varied from 0.2 to 0.8 m/s, and the wall temperatures of the pipe were measured by thermo-couples.

In the experiments effected, the rate of heat transfer showed an increase of about 50 per cent in the first method, and about 120 per cent in the second method compared with those of smooth pipes.

If we consider the power (the flow resistance times the flow rate of water), necessary for the same rate of heat transfer, we gain nothing from the first method, whilst, with the second method the power can be saved by more than 50 per cent, using a suitable form of wire, when the heat transfer rate is about 3000 kcal/h m^2 C°.

The most suitable forms of wire are such as circular wire, wound in a polygon, or wire of rain-drop form, wound in a circle, which has a rather little resistance to the flow of water and a small contact surface with the pipe wall.



"We're on our way to reduce the cost of controlling the steam, water, gas, air, oil or acid in pipe lines. Know we'll make good, for there's a half century of know-how back of the plant where we were born."

Write for Catalog No. 21. It illustrates and describes more than 140 different types.

Fairbanks Valves

The Fairbanks Company
Valves, Hand Trucks, Wheelbarrows and Dart Unions

396 Lafayette St., New York, N. Y.

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Factories: Binghamton, N. Y.; Rome, Ga.

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Certainly, it is not necessary for YOU to experiment when you may use Auditorium Patented Systems which have been proved and accepted. Twenty-five of these patents which have already been issued together with numerous pending applications, represent the achievements of the best minds in the air conditioning industry. Auditorium has made all of them available to anyone. These patents represent practical, useful and tested systems, and you are at liberty to select the features of any or all which you think will best contribute to the system which you are designing.

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(Division of B. F. Sturtevant Co.)
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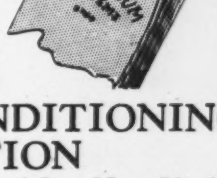

AUDITORIUM CONDITIONING CORPORATION
New York Office—17 East 42nd St., New York

This gain of power decreases, however, with the increase of the heat transfer rate.

A new method for making artificial ice rinks. J. F. H. Koopman, Holland.

A description is given of a patented artificial ice rink system, the essential feature of which is that the freezing plate has no brine piping whatever.

The cooling liquid flows on the bottom of the plate in which the ice rink is to be produced and the water is frozen upon this liquid either by direct contact or with a thin layer of some special liquid (fluid at least at the start of the operation) interposed between the water and the cooling medium.

An experimental rink incorporating this principle was built and tested. The results obtained and the economy of the new system are discussed.

Cooling of railway carriages by expansion of air. J. van Stappen, The Netherland Railways.

The Netherland Railways have installed in two two-car electric train sets on the Rotterdam-Hook line of Holland a cooling installation working on the air expansion principle.

Till now it was not possible to use the expansion of air in an economic way, the conventional type of air machine requiring too much power. In the Lèbre system there is no successive compression and expansion. These processes are performed in a combined and continuous manner in the "Lèbre heat pump" which requires only a rather small power.

A great advantage is that the medium is nothing but air, which is heated in winter operation and cooled in summer operation.

Book Reviews

Heating, Ventilating and Air Conditioning

"Principles of Heating, Ventilating and Air Conditioning," by Arthur M. Greene, Jr., Dean and Professor of Mechanical Engineering, School of Engineering, Princeton University. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. 446 + vii pp., 6x9 in., clothbound. Price, $4.50.

This work has been written primarily as a text book for a college course in heating, ventilating and air conditioning, although the author has endeavored to bring all data for design into the one volume in order that it may serve engineers and architects as a handbook as well. The subject has been developed with the same object and in the same order as in the author's earlier text, the present writing being brought up to date by the inclusion of the results of recent research work, particularly that of the *American Society of Heating and Ventilating Engineers* and the University of Illinois, and a more complete discussion of air conditioning.

There are fourteen chapters, supplemented by a 38 page appendix of tabular data and including numerous drawings of commercial equipment which serve to illustrate the principles of the subjects discussed. Problems are given at the end of each chapter.

The chapter headings are: methods of application; properties and conditioning of air; loss and gain of heat through walls; radiators, valves, and heat transmission from radiators (including a thorough treatment of the principles of heat transmission from radiators); calculating heat required for rooms; direct steam heating, hot water heating, indirect steam heating—air flow—gravity systems; indirect steam heating—plenum system—air conditioning; unit heaters—air conditioning; warm air furnace heating; furnaces, boilers, heaters; automatic controls; district heating.

Corrosion Resistance of Metals and Alloys

"Corrosion Resistance of Metals and Alloys," by Robert J. McKay and Robert Worthington. Published by Reinhold Publishing Corp., 330 W. 42nd St., New York, N. Y. 492 pp., 6x9 in., clothbound. Price, $7.00.

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A "HUSKY" D.C. Automatic Motor Starter rated up to and including 10 H. P., 230 volts non-reversing.

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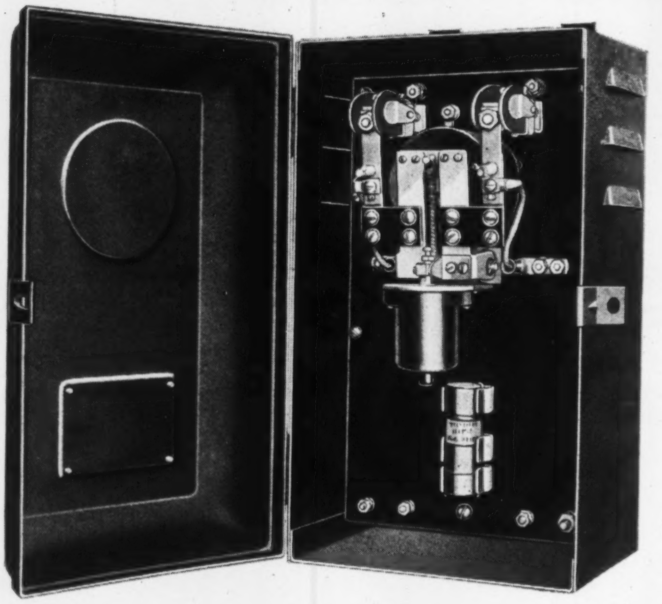

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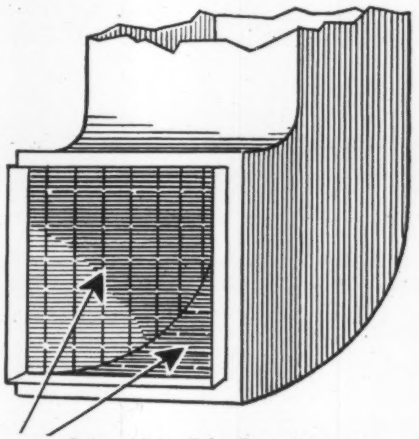

Ozite Hair Felt Duct Lining

- **Efficient sound deadener**
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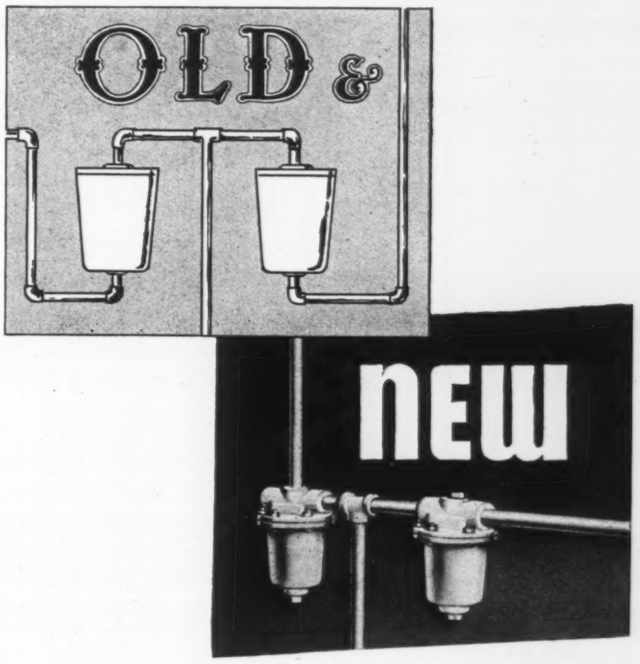

THE illustrations above show the comparison of two piping layouts for "two steam traps discharging into a common return line." The *new* piping layout is a recent Super-Silvertop installation. The *old* is the neatest arrangement possible, using ordinary, out-of-date traps. Old style steam traps required complicated piping. The location of inlet and outlet made such piping a necessary evil. The unique design of Super-Silvertop makes such puzzle piping unnecessary.

Simplified Super-Silvertop piping does more than make a neat, clean-cut piping job—it saves 40 to 60 minutes' installation time per trap, and saves the cost of extra fittings necessary for old style piping. Remember too, that Super-Silvertop operates on vacuum as well as pressure—proof that it does not leak steam. It also averages 76% greater condensate capacity, regardless of pressure and handles ordinary scale and dirt without the use of a strainer.

Send us a rough sketch of your piping layout and let us show how the use of Super-Silvertops simplifies and saves—no obligation.

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The purpose of this volume (which is one of the *American Chemical Society* "monograph series") is to summarize the facts on corrosion processes and rates, the authors state in their preface. They point out that the data given mostly cover the facts only, and offer no panacea for corrosion difficulties; the cure for most corrosion difficulties is the use of the right alloy in the right place.

Part I—general and theoretical—comprises four chapters: rate factors, forms of corrosion, corrosives, and metal corrosion properties. Part II is devoted to the corrosion behavior of specific metal and alloy groups. Following an introductory section, a chapter is devoted to each of the following: magnesium and its alloys, aluminum and its alloys, zinc and zinc coatings, cadmium plate, tin and tinplate, lead, iron and steel, silicon-iron, molybdenum alloys, chromium alloys, chromium plate, nickel-iron alloys, nickel, nickel-copper alloys, copper, and high-copper alloys (brass, bronze, nickel-silver).

Extensive bibliographies are presented at the end of each chapter, and an author and subject index is included.

The authors are associated with the International Nickel Co., Inc.

Technical Drawing Problems

"Technical Drawing Problems," by Frederick E. Giesecke, Alva Mitchell, and Henry C. Spencer. Published by the Macmillan Co., 60 Fifth Ave., New York, N. Y. 93 perforated sheets, 6x11 in., paper cover. Price, $1.40.

These technical drawing problems may be used in conjunction with any good text, but are particularly meant for use with "Technical Drawing" by the same authors. "Technical Drawing" was reviewed in the August, 1936, HEATING, PIPING AND AIR CONDITIONING, page 90, back section.

Trapping and Venting Blast Coils

THE EDITOR—We have nine blast coils comprising about 2900 sq ft of radiation. We are contemplating on checking these coils into one return line and trap this line to our receivers. We have about 8000 ft of direct radiation going to the same receiver operating at 2 to 5 lb. We expect to use one pump to return all this condensate to our boilers. Do you think we will experience difficulty by this?

Could we check these low pressure direct radiation or use thermo traps?

Should we put air vents on our blast coils? These blast coils are one on a floor in a nine story building taken off a vertical riser.—Plant Engineer.

REPLY—More information is necessary:

1. Are the nine blast coils each one section of convector across the air stream, or does each one comprise several successive sections, and if so, how many? Usually there are three or five such sections and more or fewer may be shut off as desired to obtain temperature regulation.
2. Is it correct that there is no vacuum pump, and that steam is delivered to the entire system from a single supply at from 2 lb to 5 lb for both the blast coils and the direct radiators?
3. Do the blast heaters warm recirculated air or does the air which they heat come from out of doors?
4. What make are the blast coils?

Almost certainly the answer is that all sorts of trouble will be encountered unless every individual section has an air vent located so as to release the air, and a trap, not of thermostatic type but of float type. Also the direct radiation return main should be trapped separately and air vented on the radiator side of the trap. The reasons for this, with proper location of the air vents on the blast heaters, can be developed after the requested information is received.—SAMUEL R. LEWIS*.

---

*Consulting Engineer, Chicago, Ill. Member of Board of Consulting and Contributing Editors.

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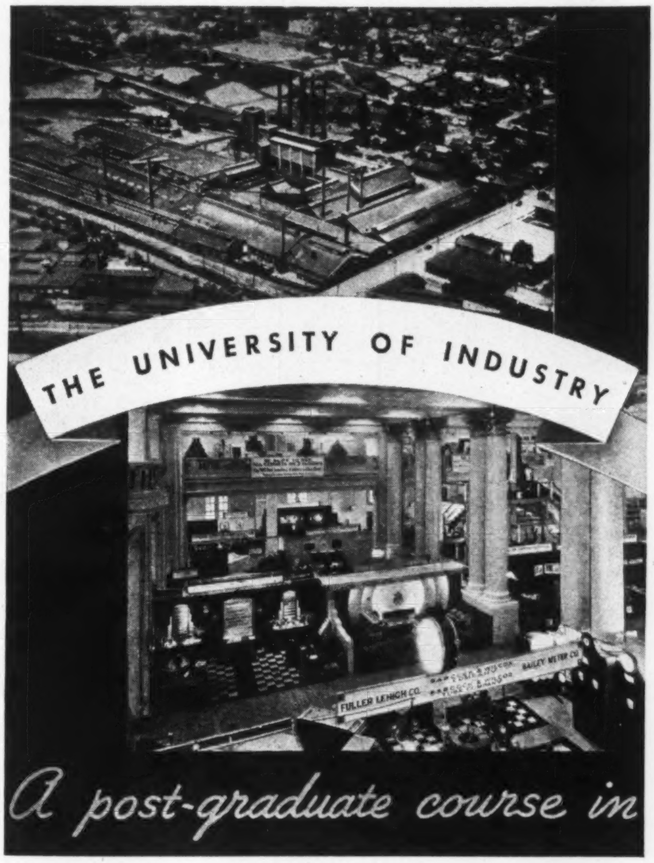
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No man in any way interested in heating, piping and air conditioning can hope to be abreast of modern developments and trends without absorbing the vast fund of practical information that this "Power University" makes available to him.

Set down, on your calendar, November 30 to December 5 as the dates when you and others of your organization will attend the

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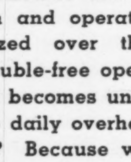
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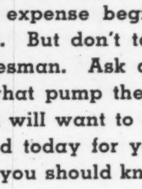
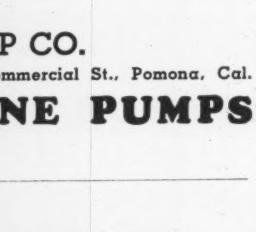
Unit heaters — for ceiling suspension available in 24 sizes and capacities from 18,000 BTUs to 658,000 BTUs per hour.


Floor Type Unit Heaters

Floor type unit heaters—ranging in capacities from 120,000 BTU to 800,000 BTU per hour.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Conventions and Expositions

American Welding Society: Annual meeting, October 19-23, Hotel Cleveland, Cleveland, Ohio. Headquarters Office, 33 W. 39th St., New York, N. Y.

National Metal Congress and Exposition: October 19-23, Cleveland, Ohio.

American Public Health Association: Annual meeting, October 20-23, New Orleans, La. Headquarters Office, 50 W. 50th St., New York, N. Y.

American Gas Association: Convention, week of October 26th, Atlantic City, N. J. Headquarters Office, 420 Lexington Ave., New York, N. Y.

National Association of Practical Refrigerating Engineers: Annual meeting and exhibit, November 10-13, Drake Hotel, Chicago, Ill. Secretary, Emerson Brandt, 228 N. La Salle St., Chicago, Ill.

International Acetylene Association: Annual convention, November 18-20, Jefferson Hotel, St. Louis, Mo. Headquarters Office, 30 E. 42nd St., New York, N. Y.

Twelfth National Exposition of Power and Mechanical Engineering: November 30-December 5, Grand Central Palace, New York, N. Y. Manager, Charles F. Roth, Grand Central Palace, New York, N. Y.

American Society of Mechanical Engineers: Annual meeting, November 30-December 5, New York, N. Y. Secretary, C. E. Davies, 29 W. 39th St., New York, N. Y.

American Society of Refrigerating Engineers: Annual meeting, December 2-4, New York, N. Y. Secretary, D. L. Fiske, 37 W. 39th St., New York, N. Y.

National Warm Air Heating and Air Conditioning Association: Winter meeting, December 15-17, Stevens Hotel, Chicago, Ill. Managing Director, Allen W. Williams, 50 W. Broad St., Columbus, Ohio.

American Society of Heating and Ventilating Engineers: Annual meeting, January 25-27, Hotel Statler, St. Louis, Mo. Secretary, A. V. Hutchinson, 51 Madison Ave., New York, N. Y.

Booklets, Reports and Papers

Standard Markings for Valves and Fittings

A new edition of the MSS "Standard Practice" covering MSS Standard Marking System for Valves, Fittings, Flanges and Unions, SP-25-1936, has just been issued by the *Manufacturers Standardization Society of the Valve and Fittings Industry.*

The method of applying the general rules for marking as set forth in SP-25 is more specifically visualized in this new edition, by the inclusion of a number of tables definitely outlining the standard method of applying uniform markings to a wide variety of products. This revised edition is issued primarily for purposes of clarification and does not alter the general principles outlined in the 1934 standard, according to John J. Harman, General Secretary of the Society.

SP-25 is one of a series of standard practices developed and published by the *Manufacturers Standardization Society of the Valve and Fittings Industry.* Copies of this 17 page booklet may be secured from the Society, 420 Lexington Ave., New York, N. Y., at 50 cents each.

Air Conditioning Conference and Coal Utilization Course Papers Published by U. of I.

The papers presented at the first annual conference on air conditioning held at the University of Illinois last May have been published as Circular No. 26 of the Engineering Experiment Station of the University, Urbana, Ill. Included in the circular

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NO such thing exists—somebody pays! Free service has caused more failures in the refrigeration industry than all other causes combined. No guarantee given by a manufacturer can compensate you for the cost of service calls. Poor design of the installation and cheap equipment invariably result in a loss.

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An installation SERVICE-FREE is the profitable one. Proper low side design, correct liquid distribution and the best control devices money can buy show the greatest profits.

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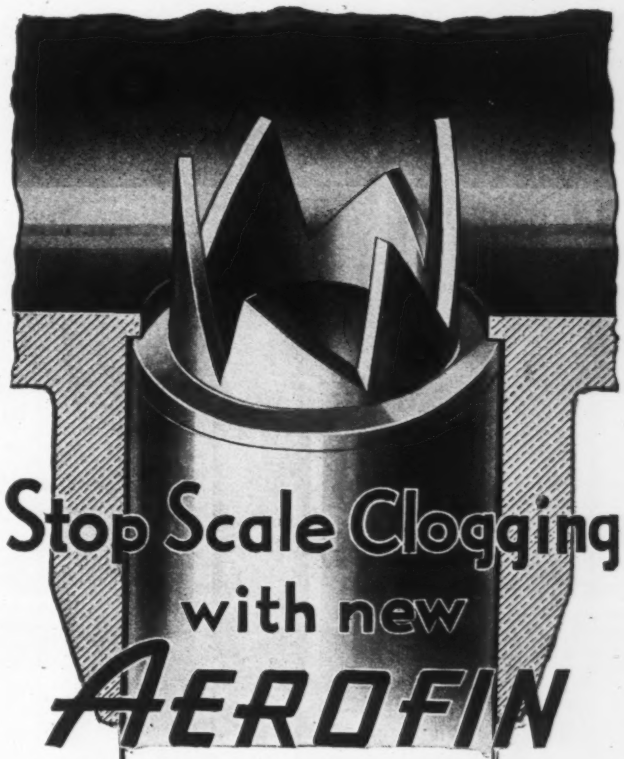

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SCALE is one of the most troublesome problems encountered in steam circulation. You know what happens. Clogging of tubes, improper steam circulation, possible freezing of tubes in cold weather and lowered efficiency at all times.

Don't let this worry you any longer. The new Aerofin Crown Orifice has been designed to overcome just such difficulties. Scale simply can't lodge in the tube opening of Aerofin heating surface equipped with the Crown Orifice. The irregular projecting points (see illustration above) set up an effective barrier against scale, yet allow free passage of steam when required. *The sharp points also break up the scale so that it can easily pass through the tubes.*

The Aerofin Crown Orifice is another example of the outstanding merit of Aerofin forced air heating surface and another of the many reasons why architects, consulting engineers and progressive heating contractors specify Aerofin. It's a typical example too, of the way that Aerofin brings you timely improvements that solve practical heating problems.

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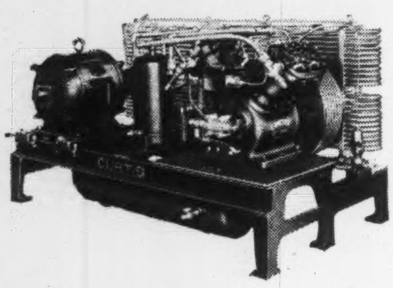

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are the following papers: What Is Air Conditioning? by A. C. Willard; Comfort Conditions and Physiological Factors in Air Conditioning, by F. C. Houghten; Air Conditioning and Its Effect on Hay Fever and Pollen Asthma, by William H. Welker; Physical Factors Affecting Comfort, by A. P. Kratz; Air Filters in Air Conditioning Systems, by F. B. Rowley; Air Conditioning Equipment, by E. L. Broderick; Essential Features of Heating Systems, by P. E. Mohn; Estimating the Humidification Requirements of Residences, by William H. Severns; Factors Affecting Fuel Saving, by S. Konzo; Calculation of the Refrigerating Load, by H. J. Macintire; Research in Summer Cooling at the University of Illinois, by M. K. Fahnestock.

The Station has also reprinted the papers presented at the second annual short course in coal utilization held last June. Included are: Coal Analyses and Their Interpretation, by A. C. Callen; Boiler Test Calculations, by W. H. Severns; Economics of Coal Preparation, by D. R. Mitchell; Advantages and Disadvantages of Coal Treatment, by J. L. Criswell; Oil for Dustless Treatment, by Berry N. Beaman; Stoker Engineering and Marketing, by T. A. Marsh; Fuel Engineering Technique, by Julius Gordon Bently; Stokers and Stoker Coal, by A. O. Dady; Heating Values Made Easy, by A. C. Callen; Heat Loss Calculations for Space Heating, by A. P. Kratz; Control Equipment, by S. Konzo; Results of the "Glover Plan," by H. A. Glover; The Answer to the Coal Man's Problems, by C. V. Beck; "Trouble Shooting" in the Domestic Field, by Carl J. Klermund; Packaged Fuel, by R. F. Mitten; Ash and Its Fusibility, by W. D. Langtry; Essentials of Air Conditioning, by M. K. Fahnestock; A New Purpose in Boiler Tests, by Joseph Harrington; An Analysis of the CWA Real Property Inventory, by C. M. Smith; Fuel Advertising and Sales Promotion, by C. Franklin Brown.

Also recently issued is a complete list of the publications of the Station, giving the titles of 284 bulletins, 26 circulars and 6 reprints.

Until March 1, 1937, or until the supply available for free distribution is exhausted, copies of these publications may be obtained without charge upon application to the Station.

Analysis of Flow in Networks of Conduits

The problem of finding the distribution of flow in networks of pipes occurs in the design of distribution systems for water. Similar problems occur in connection with distribution systems for other fluids such as steam or air, and with electric circuits. In general, the analysis of such systems by formal algebraic procedure is, if the systems are complicated, very difficult. Models have been used in studying the problem, but here, as elsewhere, there are some objections to their use.

The methods of analysis presented in Bulletin No. 286 of the Engineering Experiment Station of the University of Illinois, Urbana, Ill., "Analysis of Flow in Networks of Conduits or Conductors," by Hardy Cross, Professor of Structural Engineering, which has just been issued, are methods of successive corrections. The convergence is apparently sufficiently rapid in all cases to make the methods useful in office practice.

Where the relation between flow and head (or between current and voltage) is linear, the corrections are exact. Where this relation between flow and head is not linear, use is made of the relation between increment of flow and increment of head, the relation being linear for a given quantity of flow. If the increments are fairly large, however, this linear relation will be somewhat in error, but a sufficiently exact solution is nevertheless obtained by successive correction. The method thus involves an arithmetical application of the fundamental principle of the differential calculus.

Several problems of flow, illustrating the use of the methods, are described in detail in the bulletin, and additional applications of the methods presented are suggested.

Until March 1, 1937, or until the supply available for free distribution is exhausted, copies of this 29 page bulletin may be obtained without charge upon application to the Station.

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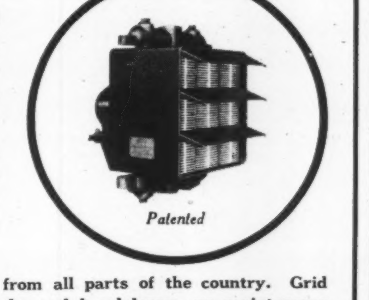

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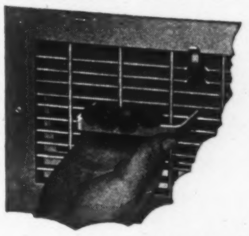

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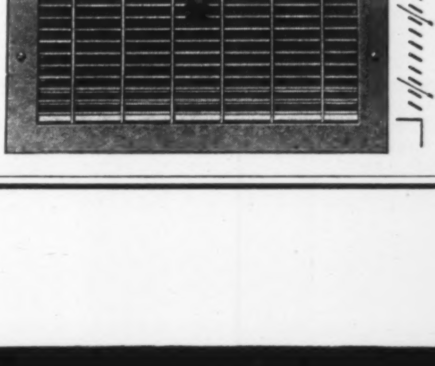

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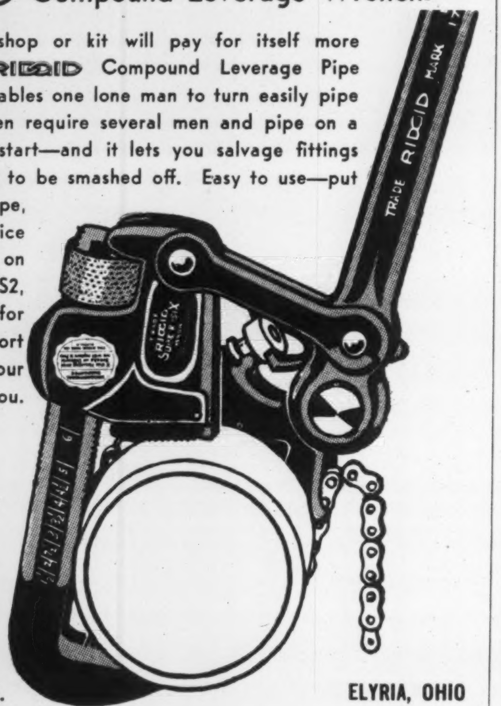

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Preventing Scale in Steam Boilers

The purpose of the investigation described in Bulletin No. 283 of the Engineering Experiment Station of the University of Illinois, Urbana, Ill., "A Study of the Reactions of Various Inorganic and Organic Salts in Preventing Scale in Steam Boilers," by Frederick G. Straub, Special Research Assistant Professor of Chemical Engineering, which has just been issued, was to study methods of chemical treatment which might be used for the prevention of the various types of scale which form in steam boilers.

Since the chemical treatment of boiler water may be readily classified under two distinct headings, inorganic and organic, it was thought advisable to divide this study into two parts.

The first part describes the results obtained in scale prevention by the use of various inorganic salts; the second part describes the results obtained by the use of various organic materials such as the so-called tannin extracts.

The tests were run in a bomb apparatus, and in a small laboratory boiler arranged so that the conditions of the test could be varied as desired. The tests indicated that both inorganic and organic materials could be used successfully to hold the scale forming materials in solution in the boiler water, and thus prevent the formation of scale.

Until March 1, 1937, or until the supply available for free distribution is exhausted, copies of this 116 page bulletin may be obtained without charge upon application to the Station.

Recent Trade Literature

For your convenience in obtaining copies of bulletins, see coupon on page 126

No. 2129—AIR COMPRESSORS: Worthington Pump & Machinery Corp., Harrison, N. J., 4 p. bulletin on steam driven single direct acting air cooled air compressors adapted for high pressure or low pressure steam, giving dimensions, specifications and listing applications.

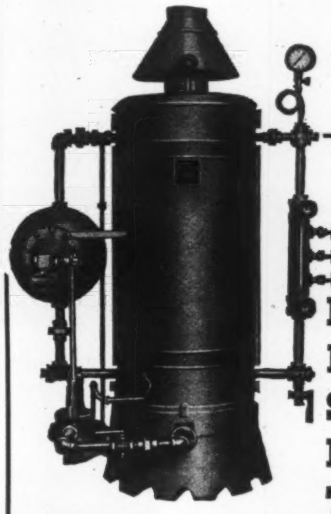
No. 2130—AIR CONDITIONERS: National Air Conditioning, Inc., Div. of National Radiator Corp., 101 Park Ave., New York, N. Y. 4 p. data bulletin on self-contained summer air conditioners (essentially portable room coolers) in air cooled and water cooled types. Features are described in detail and engineering data are presented.

No. 2131—AIR CONDITIONING: Westinghouse Electric & Mfg. Co., Mansfield, O. Folder describing reversed refrigeration heating and air conditioning system for the Southern Sierras Power Co., Riverside, Calif., illustrating and describing the equipment installed and showing graphs of performance. Heat is pumped from well water into the building in cool weather, and from the building to well water in warm weather.

No. 2132—BOILER WATER LEVEL CONTROL: McDonnell & Miller, 1316 Wrigley Bldg., Chicago, Ill. 32 p. catalog of boiler water level controls, with information on the necessity of boiler water level control, describing features of the equipment, giving capacity charts, and illustrating and describing safety feeders for hand fired boilers, combined safety feeders and low water cut-offs, low water cut-offs, combined low water cut-offs and pressure controls, high and low liquid level switches, water level control for humidifier pans and various special products.

No. 2133—BRAZING ALLOYS: Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. 12 p. bulletin on "Phos-Copper" brazing alloy for brazing on copper, brass and bronze, describing features, illustrating applications and presenting test and technical data.

No. 2134—COILS: Fedders Mfg. Co., Inc., 57 Tonawanda St., Buffalo, N. Y. Issue of "Fedders News," Vol. 3, No. 8, including an article by Joe Askin on the distribution of refrigerant in air conditioning coils.



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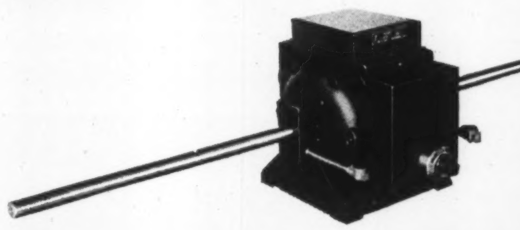

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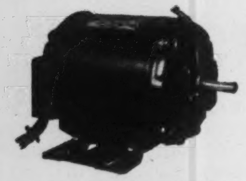
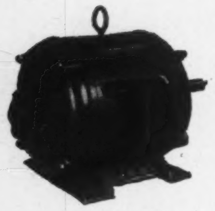


AIR CONDITIONING MOTORS



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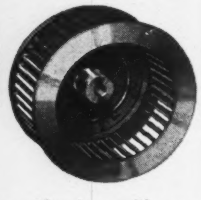

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No. 2135—COILS: Marlo Coil Co., 6135 Manchester Ave., St. Louis, Mo. 13 p. looseleaf catalog describing "Humidair" coil-pan, unit coolers, air conditioning units, cold water cooling unit and angle fin plate coil, and presenting specifications, list prices and capacities. Several mechanical data sheets are included for dry expansion coils, with specifications and list prices.

No. 2136—COMPRESSORS: York Ice Machinery Corp., Roosevelt Ave., York, Pa. 16 p. bulletin describing in detail the features of ammonia refrigeration compressors ranging in size from 6 by 6 in. to 12½ by 14 in. with V-belt drive, synchronous motor drive, or flat belt drive. Dimensional tables are included.

No. 2137—CONTROLS: Perfex Controls Co., 415 W. Oklahoma Pl., Milwaukee, Wis. Looseleaf catalog of automatic controls, including thermostats, warm air and fan controls, hot water controls, pressure controls, combustion controls, relays, stoker timers, refrigeration pressure controls, refrigeration temperature controls, solenoid valves for water and refrigeration, and others. Detailed information on application, operation, construction and installation of the controls is given.

No. 2138—DRIVES: Dayton Rubber Mfg. Co., Riverview Ave., Dayton, O. 80 p. manual on "Cog-Belt" drives, entitled "The ABC's of V-Belts," the first section of which tells the construction story, and the second part points out the application of these drives and shows over 200 pictures of a wide variety of installations alphabetically arranged by industries.

No. 2139—DRIVES: B. F. Goodrich Co., Mechanical Rubber Goods Div., Akron, O. 27 p. catalog of fractional horsepower V-belts and their application, including a set of tables giving center distances corresponding to every standard "Goodrich" belt for various speed ratios, motor speeds and pulley diameters. Complete dimensions are listed and data on installation and care of V-belts and application of belts to the V-flat drive are included.

No. 2140—HEATING ACCESSORIES: American Radiator Co., 40 W. 40th St., New York, N. Y. (a) 4 p. bulletin on direct and indirect heaters for domestic hot water, with information on construction, application, sizes, ratings and dimensions. (b) 4 p. bulletin on air, vacuum and vent valves for venting radiators and mains on one-pipe steam and vacuum systems. (c) 4 p. bulletin on pressure and temperature regulators and controls for steam, water and vapor. (d) 4 p. bulletin illustrating and describing the products of H. A. Thrush & Co. and McDonnell-Miller Co. (e) 4 p. bulletin on packed and packless radiator valves, a complete line for all heating purposes.

No. 2141—HEATING EQUIPMENT: William S. Haines & Co., 12th and Buttonwood Sts., Philadelphia, Pa. 16 p. catalog of steam heating specialties, including packless radiator valves and many types of traps, including radiator and high and medium pressure traps.

No. 2142—HEATING SPECIALTIES: Gorton Heating Corp., Cranford, N. J. Trade price sheet on equalizing valves and air eliminators for steam and vapor systems.

No. 2143—HUMIDIFIERS: Maid-O-Mist, Inc., 45 E. Ohio St., Chicago, Ill. Folder describing "Auto-Vent" humidifier device for application to vapor or steam radiators.

No. 2144—INDUSTRIAL PRODUCTS: Johns-Manville Corp., 22 E. 40th St., New York, N. Y. 60 p. catalog containing information and recommendations on high and low temperature insulations for a variety of industrial uses, "Transite" pressure pipe for industrial and municipal water lines, packings, rock cork pipe covering, and other products.

No. 2145—MOTORS: Bodine Electric Co., 2254 W. Ohio St., Chicago, Ill. Issue of "The Bodine Motorgram," Vol. 16, No. 3, including notes on characteristics and uses of capacitor motors.

No. 2146—NICKEL ALLOY STEEL: The International Nickel Co., Inc., 67 Wall St., New York, N. Y. 14 p. bulletin on the properties and applications of heat treated wrought nickel alloy steels (in sections up to about 6 in. in diameter or thickness), designed to aid selection of suitable steels to meet modern industrial demands of the product or plant equipment. A number of "mechanical property" charts are included.

No. 2147—ODOR ADSORBERS: Consolidated Air Condi-

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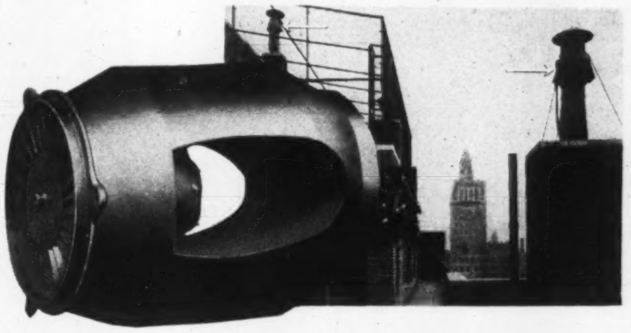

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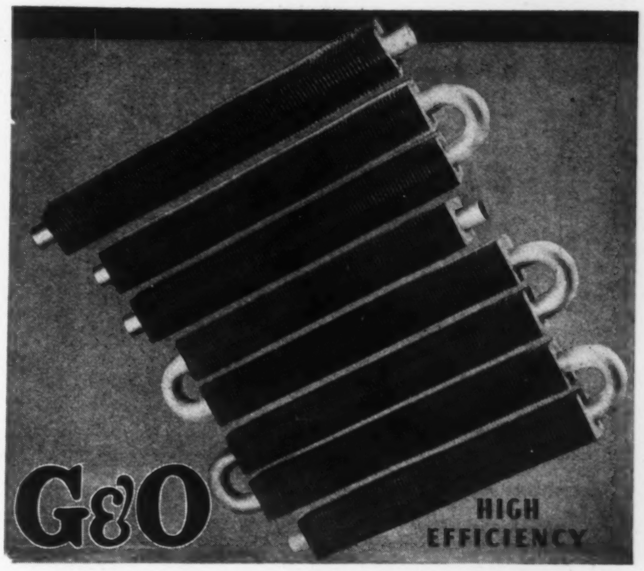

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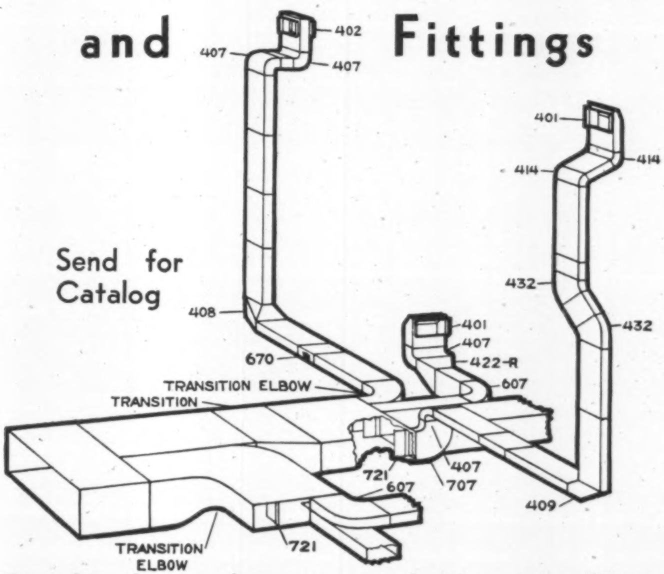

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tioning Corp., 192 Lexington Ave., New York, N. Y. 8 p. bulletin on use of odor adsorbers in connection with air conditioning, featuring economy in heating and cooling through the use of odor adsorbers by enabling increased recirculation of air.

No. 2148—PIPE TOOLS: Beaver Pipe Tools, Inc., 310 Dana, N. E., Warren, O. 40 p. catalog of pipe tools, illustrating and describing them in detail. Included are pipe machines, ratchets, threaders, reamers, pipe and tubing cutters, and other equipment.

No. 2149—PROCESS EQUIPMENT: Edge Moor Iron Co., Edge Moor, Del. 8 p. bulletin of special equipment for the process industries fabricated from steels, stainless steels, aluminum, stainless clad and various alloys.

No. 2150—PUMPS: Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago, Ill. (a) 16 p. bulletin on "Built-Together Pumps," consisting of centrifugal pumps with enclosed bronze impellers mounted directly on the shafts of ball bearing motors; adapted for general pumping services in capacities up to 900 gpm and heads up to 260 ft. Pump selection tables for water and brine are presented, and sizes and dimensions are given. (b) 16 p. catalog of single stage, split case centrifugal pumps, describing features, giving specifications and tabulating principal dimensions.

No. 2151—PUMPS: Worthington Pump & Machinery Corp., Harrison, N. J. 4 p. bulletin on two stage, volute centrifugal pumps, illustrating and describing construction.

No. 2152—SPEED REDUCERS: Janette Mfg. Co., 556 W. Monroe St., Chicago, Ill. Leaflet describing motorized speed reducers of various types, presenting selection data for each.

No. 2153—STEAM JET WATER COOLERS: Graham Mfg. Co., Inc., 220 Delaware Ave., Buffalo, N. Y. 12 p. bulletin of steam operated water cooling units for furnishing water at any temperature down to 35 F, describing types of coolers and their application, construction of the equipment, dimensions, frame capacities, condenser water requirements, and presenting data on control.

No. 2154—STEAM TRAPS: V. D. Anderson Co., 1949 W. 96th St., Cleveland, O. 8 p. bulletin illustrating applications of "Super-Silvertop" steam traps in draining unit heaters, kettles, air conditioning equipment, and for general applications.

No. 2155—STOKERS: Auburn Foundry, Inc., Auburn, Ind. 12 p. bulletin on worm feed stokers, describing and illustrating construction and manufacturing facilities; also a series of leaflets featuring this company's stoker.

No. 2156—STOKER CONTROLS: Paragon Electric Co., 37 W. Van Buren St., Chicago, Ill. 4 p. bulletin on stoker controls, time relays, timers and time switches.

No. 2157—STORAGE WATER HEATERS AND TANKS: Lukens Steel Co., 104 S. First Ave., Coatesville, Pa. 8 p. bulletin on storage water heaters and tanks of nickel clad steel (nickel on inside, steel on outside), featuring the corrosion resistance and strength of this type of construction, and including table of normal capacities and dimensions.

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